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TELEPHONE ENGINEER

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Volume XXII *SEPTEMBER 1919* *Number 3*

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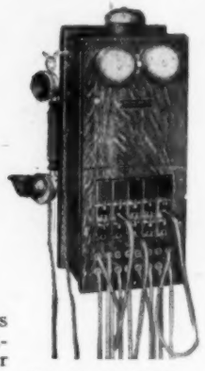

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TELEPHONE ENGINEER

Edited by Paul H. Woodruff

Published Monthly by The Telephone Engineer Company, Monadnock Block, Chicago.

H. B. McMEAL, President and Treasurer. *J. M. GRAFFIS,* Vice President and Advertising Manager. *C. W. HIGGINS,* Secretary.

VOL. XXII *Chicago, September, 1919.* *No. 3*

Publisher's Announcement

On August, 1, 1919, TELEPHONE ENGINEER was purchased by the Telephone Engineer Company, of which H. B. McMeal is president and treasurer, J. M. Graffis, vice-president and advertising manager, and C. W. Higgins, secretary. The publication will continue under the editorial management of Paul H. Woodruff.

Something New in Organizations.

WITHIN the last few weeks reports have come in of two events whose significance may be greater than at first appears. Both of them concern the formation of new organizations. Beyond that fundamental they seem unrelated; but there is little doubt that both are the outcome of the present labor situation.

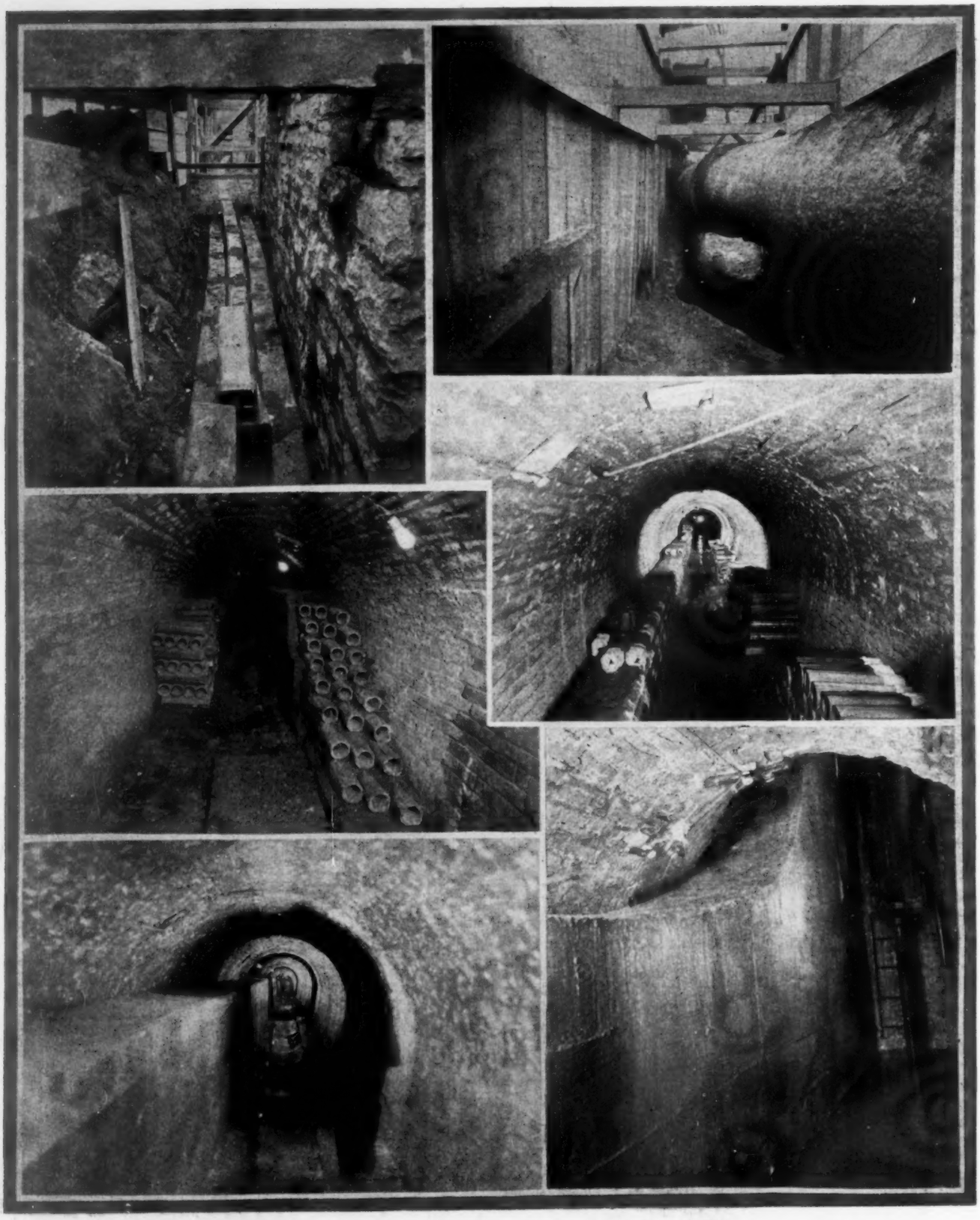
Sixteen thousand employees of the Southern Bell have organized, the first report says, an association that is not in any sense a labor union, and yet its purpose is to bridge the so-called gulf between employee and employer, to deal with the grievances, if any, of the workers, and in fact, to undertake a species of "collective bargaining." The point in which the new society differs exceedingly from labor unions is that its plan is to coöperate with the employer. For that reason it undoubtedly will be disapproved and condemned by "labor."

So far as we know, this scheme of organization is new to the telephone operating business. Something similar has been tried, or is being tried, by a telegraph company, but telephone organization is rather different from telegraph. We believe there is no intention to obscure the thought that the company executives gave their influence, direct or indirect, to the project. Since the company is equally concerned with the workers in whatever changes may be inspired, it should be obvious that the ideal industrial organization includes both sides of the situation—those behind the pay window and those in front of it. In this respect labor unionism is as far as possible from ideal.

The logical way to combat the growing radicalism of labor organizations is to form organizations less radical, better directed and with a better sense of responsibility. Those employers who are sincere in their desire that the welfare of employees shall be promoted to the greatest reasonable degree—and most employers are in that class—will watch the workings of the southern association with absorbed interest. Still believing that the majority of workers are sane and reasonable, in spite of recent contrary evidence, we are optimistic enough to wonder if the new plan may not be the solution of the labor situation.

The second report tells of the organization of a considerable body of security holders in Michigan telephone properties. The suggestion in this is that the worm shows symptoms of turning. So far, amid the insistences of labor and consequent up-curves of material prices, the stockholder has been consistently —to borrow another epithet from natural history—the goat. Figured on the value of returns, the investor now is doubly the loser; for his five to eight per cent has only half its former power, and there is some doubt of his continuing to get even that. Yet we have heard no rumors of capital striking for a fifty per cent increase in earnings, though such a course is quite as logical as similar action on the part of labor. Suppose capital should "go out" for a raise—the four-per-cents for six, the eight-per-cents for twelve; suppose it refused to work at all until its demands were met. What then would become of the already complex tangle of current economics?

No danger, of course. Capital, generally speaking, will continue to take what it can get, regulated by the competition for its services. But the "capitalists" themselves, who in many cases may be the widows of thrifty workingmen, need some share in the benefits of organization, and we are glad to see them getting it. We expect to find associations of public-utility investors becoming a popular movement if the other demands on gross revenue continue to increase.



UNUSUAL CONDUIT WORK IN CHICAGO TUNNELS UNDER THE CHICAGO AND CALUMET RIVERS.

Beginning at the top, left to right (1) *Conduit leading into Ninety-fifth street tunnel.* (2) *Thirty-six-inch water main and brick sewer running through conduit trench at Ninety-fifth street and the Calumet River.* (3) *Irving Park boulevard tunnel, showing conduit formation at east end.* (4) *Ninety-fifth street tunnel, looking east, showing conduit being laid.* (5) *Ninety-fifth street tunnel, showing complete encasement of conduit in concrete.* (6) *Ninety-fifth street tunnel, showing complete concrete encasement of conduit at bottom of each shaft. Note pump. Forty-eight hours after completion the water had filled the bore and risen in the shafts to the river level.*—"Bell Telephone News."

Tree Telephony and Telegraphy

Signal Corps Experiments Detailed in the Journal of the Franklin Institute

By MAJOR GENERAL GEORGE O. SQUIER

IN connection with the organization and development of Transatlantic radio reception which was carried out during the period of the war to provide against the possibility of the interruption of the submarine cable system, the Signal Corps established a chain of special receiving stations in different parts of the United States to copy and record enemy and allied radio messages from European stations for the information of our Army General Staff.

In the prosecution of this work, directions were given to the Signal Corps Laborotory at Camp Alfred Vail, Little Silver, New Jersey, and also to the experimental staff in Washington to test the efficiency of growing trees as receiving antennæ in connection with this service, using the vastly superior technic and facilities now represented in the radio art as compared with the crude apparatus with which the discovery was made in 1904. With a collection of apparatus representing the most advanced state of the radio art, the problem, as a war measure, was attacked anew and has now reached a point when a very brief outline of some of the physical results obtained should be presented in the interests of the development of the art in general. Since the phenomena involved embrace a variety of physical problems rather than strictly engineering ones, these data are presented to the Physical Society in the hope that some of its members may see in the experiments some points of departure for further research.

It was immediately discovered that with the sensitive amplifiers now in use it was possible to receive signals from the principal European stations by simply laying a small wire netting on the ground beneath the tree and connecting an insulated wire to a nail driven in the tree well within the outline of the tree top.

This encouraging first result justified a more careful examination of the phenomena and the most suitable arrangement of circuits for the purpose.

Without entering into the details of these preliminary experiments it may be said that one of the best receiving arrangements is found to be an elevated tree earth-terminal in the upper part of the tree top as described later, and an earth consisting practically of several short pieces of insulated wire sealed at the outer ends radiating out from a common center, and buried a few inches beneath the surface of the ground in the neighborhood of the tree.

Pine tree used in experiments. Average diameter about 25 cm. Signal Corps floraphone laboratory at the right.

It was soon found that a tree-antenna could be used efficiently as a multiple receiving set over widely different wave lengths, receiving either from separate terminals at the same or different heights of the tree or in series from the same terminal.

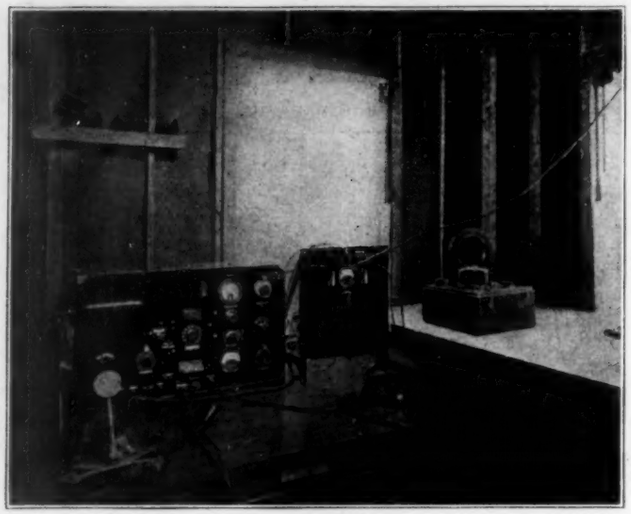
This same type of circuit was employed in an inverse manner for telephonic transmitting purposes, and although the experiments thus far have been limited to short distances, it was found that 2-way telephonic communication was easily established with remarkably low values of transmitting antenna current.

The flexibility of this arrangement is very striking. The linking up of wire and wireless methods was found to be convenient and efficient. Radio telephonic messages from airplanes were readily received by the tree-antenna arrangement and transferred thence to the wire system of the city of Washington and finally received at any point desired.

Forthermore, telephonic transmission through the tree-antenna was received by another tree-antenna, and automatically returned to the sender on a wire system, thus making the complete circuit. Long distance reception on any wave length from all the larger European stations and from our ships at sea was easily accomplished and traffic copied on a twenty-four-hour schedule by the regular enlisted operators of the Signal Corps. A small portable house serving as a field laboratory was erected in the midst of the forest area on Grant road, Washington, D. C., between the Bureau of Standards and Chevy Chase, Maryland, and here was assembled a collection of the most efficient vacuum tube amplifiers developed to date by the Signal Corps of the Army, the Navy, the British and the French, and of commercial firms in the United States. With these unusual facilities it was a matter of a few days to test out, at least in a superficial manner, a large number of proposed arrangements using trees as

antennæ. Second Lieutenants H. A. Browning and M. C. Batsel, Signal Corps, have been in charge of this field laboratory.

Much data on the electrical constants of tree-antennæ have been obtained by Captain F. E. Pernot.



Floraphone radio telephone apparatus arranged for transmitting and receiving with tree antenna.

Signal Corps, in charge of the Signal Corps radio research laboratory at the Bureau of Standards.

GONIOMETRIC METHODS APPLIED TO TREE ANTENNÆ

One of the special lines of radio development caused by the war has been the application of radio methods to direction finding for military purposes. The Signal Corps has evolved and standardized certain sets possessing extreme compactness for the use of the mobile forces.

Under the intensive study of this subject, stimulated by the war, a large amount of technical information has been obtained which is now available for use and application to the purposes of peace.

Through the co-operation of F. A. Kolster of the Bureau of Standards, who has specialized in this work for the Navy Department, some applications of these methods have been applied to tree antennæ.

Coil aerials of extremely small dimensions as compared with ordinary antennæ, may be effectively used for both long and short-wave long distance reception. It is therefore possible to make use of such a coil aerial in combination with the tree system, without in any way detracting from the remarkable simplicity of the tree system, for the purpose of obtaining the desirable feature of unidirectional reception or so-called "barrage" effect.

Coil aerials of very small dimensions as compared with the wave length received are nothing more nor less than ordinary inductance coils directly and magnetically exposed to the incoming electromagnetic wave, and may form the entire or the major portion of the inductance of a simple series resonant circuit. Such a circuit is shown in Fig. 1, consisting of the coil aerial L, the inductance L_2, and the capacity C_2. This circuit to which there is connected the detector and amplifier forms the secondary receiving circuit of the system and is coupled inductively to the primary circuit L_1C_1 to which the tree and ground wires are connected at T and G.

The system is unique in that both primary and secondary circuits are directly exposed to the incoming wave. It is by virtue of this double exposure that the unidirectional characteristic of the system is obtained. In other words, both primary and secondary circuits are simultaneously operated upon by the incoming electromagnetic wave and by the proper adjustment of the linking coils L_1 and L_2, the effects produced in the secondary circuit may be entirely neutralized or accumulated. Switch S shown in Fig. 1 is a reversing switch connected to coil L_2 which controls this neutralizing or accumulating effect.

Complete "barrage" effect was obtained with this system on stations such as New Brunswick, New Jersey; Annapolis, Maryland; Nauen, Germany, etc. This makes it possible, for example, to receive signals from San Diego, California, while the New Brunswick station is operating and using practically the same wave length as the San Diego station.

The coil aerials used in the experiments made with the system above described are but four feet square and therefore are located within the station, merely forming a part of the internal receiving apparatus and in no way complicating the simple tree system.

We have then a simple two-circuit receiving system requiring no extensive and costly outside aerial structure and have the following modern features:

a. Long distance reception at any wave length.
b. Direction finder giving not only the line of direction but the absolute direction.
c. Elimination of interference by virtue of the unidirectional characteristic or "barrage" effect.
d. Simultaneous reception of two or more wave lengths or of two similar wave lengths coming from opposite directions.

Heretofore, in existing operating stations the receiving circuits, of whatever nature, have operated primarily on the generation of alternating currents in the receiving antenna system, and because of this it has been necessary to tune the antenna system itself to the particular frequency of the signals. In the experiments in tree telephony and telegraphy, we may rather consider that we employ an aperiodic system in the form of the tree itself, and make use of the resultant potential effects at the upper tree terminal of this antenna, selecting from this reservoir of all frequencies

U. S. Signal Corps floraphone and floragraph laboratory and station, Grant Road, District of Columbia, April 18, 1919.

the particular frequency desired, by means of external receiving devices now known to the art.

AFTERWORD

Potential Earth-Terminal.—We may regard the metallic electrode rigidly driven into the living organ-

ism of a tree, as described above, as a potential earth-terminal for the study of the potential distribution on the surface of the earth itself. It has been shown in these experiments that this metallic terminal intimately connected to the earth itself and a part thereof is subject to changes of potential representing the innumerable frequencies required by modern radio telephony and telegraphy as well as any other electrical disturbances which may occur on the surface of the earth or the atmosphere above the earth.

It has been also shown, as expected, that we can select from this composite one or more of the different frequencies by tuned electrical loop circuits suitably connected to this electrode and study each in turn at will just as color screens can select a particular component of white light. We may, indeed, by means of a highly insulated conductor bring this terminal directly to the laboratory and connect it immediately to the modern thermionic tube and amplify almost at will the particular effects we are studying. This tube is a powerful and new instrument of research for the modern physical laboratory. Has not the physicist there-

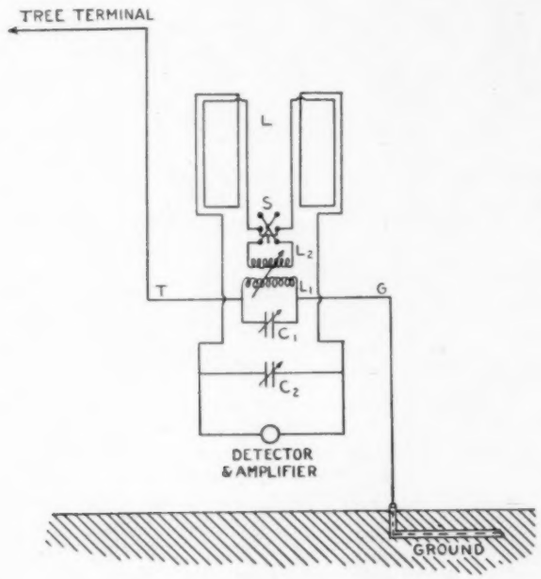


Fig. 1.

fore in this electrode a means of studying in detail atmospheric and earth electrical disturbances of absorbing interest and far-reaching importance?

In short, the radio art as a whole has attracted some of the best equipped physicists in each country as perhaps no other practical engineering subject of recent years has done, with the result that the methods and means of the radio art are now immediately applicable and available to the physical laboratory for the study of the fundamental problems of the earth itself as a charged sphere.

For four years, under the stimulus of the World War, the efforts of engineers have been expended in producing instrumentalities for the generation and reception of radio signals and there has been little time to co-ordinate and assimiliate the information gained into a better understanding of the ether mechanism for the transmission of electromagnetic waves through space, over the surface, or through the earth itself.

In the language of the modern captain of industry, physical theory is a temporary "corporation policy" rather than a fixed creed. Nevertheless, the modern specialist in science has, from the very nature of his intensive efforts, assumed what might be called a "polarized" attitude of mind toward the particular problem in hand.

The physicist and engineer, accustomed to deal with inanimate material, is here confronted with the employment of living vegetable organisms or growing trees. From the moment an acorn is planted in fertile soil, it becomes a "detector" and a "receiver" of electromagnetic waves and the marvelous properties of this receiver, through agencies at present entirely hidden from us, are such as to vitalize the acorn and to produce in time the giant oak. In the power of multiplying plant cells, it may, indeed, be called an incomparable "amplifier."

From this angle of view, we may consider that trees have been pieces of electrical apparatus from their beginning and with their manifold chains of living cells are absorbers, conductors, and radiators of the long electromagnetic waves as used in the radio art. For our present purposes we may consider, therefore, a growing tree as a highly organized piece of living earth to be used in the same manner as we now use the earth as a universal conductor for telephony and telegraphy and other electrical purposes.

All through the ages there is shown in literature a feeling of reverence, sympathy and human intimacy with trees. It is significant that this practical thing possessing utility and natural strength, architectural beauty of design, and endurance far superior to artificial structures prepared by man, should be able yet further to minister to his needs.

Michigan Security Holders Organize

A movement is on foot to form an organization of the bond and securities holders, of Michigan, who have money in the telephone companies of the state, for the purpose of offsetting "propaganda" of the League of Municipalities.

C. O. Trask, of Grand Rapids, president of the Valley Home Telephone Company, it is understood, is taking the initiative in the matter.

According to the statements attributed to him, the securities holders, comprising persons in ordinary financial circumstances, including a number of wash women, are without any spokesman.

It is known that the matter has been taken up with at least one member of the public utilities commission and that he had personally said he saw no objection to such an organization. He has suggested the national organization of holders of railroad securities be made the pattern for the proposed Michigan organization.

It is Trask's reported position that the League of Municipalities is circulating propaganda through the newspapers, that it is not interested except to "secure as much as possible for as little as possible."

To the Grand Rapids man is also attributed the belief that "The managers and attorneys come to the commission and make a lot of noise, but accomplish nothing." He further charges according to reports of his statement that telephone rates are being contested for political purposes.

Mr. Trask is reported as taking the attitude that the securities holders should not be deprived of the value of their holdings and that they should be heard by the commission.

Long-Remembered Messages

By Courtesy of "The Transmitter"

EVERY once in a while there comes over the telephone wire a sentence that becomes famous—either because of the man who utters it or the importance of the subject. Such a sentence not only becomes famous, but, on account of the circumstances surrounding the sending of it, probably lingers long in the mind of the person who received it.

Few people can remember the very first words they ever heard over the telephone, but there's one man who can. It isn't at all likely that a certain individual who is now interested in the buliding of ships will ever forget the "Mr. Watson, come here; I want you" that came faintly over a few feet of wire to him on that memorable March day of 1876.

Nor is it likely that those men of the telephone who participated in the opening of the transcontinental telephone line will forget the particular words used on that occasion; nor will those who were fortunate enough to be present when the first words were shot across the country by wireless telephone.

"THE SUN IS SHINING IN DAYTON"

There is a man in Ohio who was governor in 1913 and who could probably tell you of a telephoned sentence that stands out in his mind rather distinctly. It is: "Good morning, Governor. The sun is shining in Dayton." On that morning Dayton was a stricken city. The heavy flood and storm was upon it. It was cut off from the rest of the state. No trains in or out, no telegraphs, and only one telephone line. At the Dayton end of the line was a telephone man, District Plant Wire Chief J. A. Bell, marooned in one of the upper stories of a high building. All through the night he stayed at his telephone, sending out the only information that was sent out. And with the morning sun came his cheerful message to the governor at Columbus—a message that brought joy to the thousands waiting for it, for it meant that the storm had ceased raging and the waters would soon begin to recede.

Seven words that meant the occupation of a foreign city by American troops and possible war with one or more countries came over the telephone in the dead of night, or rather just before the first blush of dawn.

At 4 a. m. on an April day in 1914, Secretary Bryan received a cablegram from Consul Canada, stationed at Vera Cruz, Mexico, telling of the approach of a German vessel carrying a cargo of arms for Huerta. Mr. Bryan telephoned Mr. Tumulty. Mr. Tumulty called the White House, and after some hesitation President Wilson was awakened.

While Mr. Tumulty was explaining the situation Secretary Daniels, of the Navy, called up and was switched in on the same line. He, too, had received a dispatch about the cargo of arms. The President listened in silence.

"What shall we do?" asked Secretary Daniels.

"Tell Fletcher to seize the customs house," replied the President, without hesitation.

A voice in distress heard over the telephone is likely to be remembered. Think you the operator who has heard "Fire!" "Police!" or "Help!" is going to forget it immediately?

A voice may be rather casual and yet tell a big story—big enough to impress it on your brain for a while. For instance, let us suppose you are a telephone engineer, helping to hold down the job in the wilds of West Virginia. It is Sunday evening and you are at home with friend wife, congratulating yourself that "there is no place to go." The telephone bell rings and this is what you hear when you respond: "E. O., there has been a cloudburst at the head of New River and a big flood is headed this way."

It seems to be a fact that a thing heard over the telephone will linger longer in the mind than something heard face-to-face, even though the thing heard be not extraordinarily important. The reason for this is that when one listens on the telephone he usually concentrates. There is no distraction—nothing to do but listen; just as a person who cannot see usually has exceptionally keen hearing.

"ALL RIGHT, BOY"

A number of people were asked if they could recall after several years any word, phrase or sentence that had come floating over the telephone wire. One of the first of those approached said there were three words that came to him many times a year, at the most unexpected times.

When this man was a student he had a pal and roommate with whom he had quarreled. A few days later he decided to leave town for keeps, without saying good-bye to his pal. At the railroad station he was paged by the telephone attendant. It was the pal calling. A few words of reproach and then "All right, boy!" in a sad, injured, et-to-Brute tone of voice.

"I know it sounds foolish and childish and all that," said the man in mentioning the incident, "but that was ten years ago, and that dog-gone 'All right, boy!' comes back to plague me regularly. I have never seen George since, but I have often felt like looking him up and making things right with him."

Another man remembered several of these telephoned sentences that stick in the mind. "It seems to me," he said, "that the things over the telephone I remember most are the things I'd rather not remember. For instance, I called up a friend one day and when a voice answered, I asked: 'Is this you, Harry?' Came the voice: 'Harry's dead!'"

A former official of the company answered his telephone summons one day and heard: "This is Mr. Vail." The former official (thinking somebody was trying to josh him), was about to tell the owner of the voice to go to some undesirable place, but fortunately didn't. The owner of the voice was Theodore N. Vail.

Somebody told us the other day of a young woman who frequently recalls a telephoned invitation. A young man whom she had known for a long time but who had never escorted her anywhere called up and asked quite casually, if she would go to the theatre with him. All she could think of to say was: "Oh, Tom, this is so sudden!" Then she realized that there were several individuals within hearing distance.

Speaking of affairs of the heart, one young man of our acquaintance remembers a rather peevish feminine voice which demanded over the wire: "Say, are you coming up here tonight, or ain't you?" The voice was owned by his fiancee, whom he had neglected to call on for three evenings in succession.

Electromagnetic Theory of the Receiver

A Paper Presented at the 348th Meeting of the American Institute of Electrical Engineers

BY A. E. KENNELLY AND H. NUKIYAMA

ABSTRACT OF PAPER.

The theory of the telephone receiver here offered is based upon the motional impedance circle which has ben publishd in various chapters during the last few years. The new theory, which is stated under definite limitations, is a further development; taking into account the m.m.f. produced by the vibration of the diaphragm in the permanent magnetic field. The motional power is thus shown to be derived partly from the testing alternating current and partly from changes in power expended in the magnetic circuit. The motional impedance circle may therefore also be regarded as a power circle, with components along three different axes of reference.

IT is well known that every telephone receiver possesses a certain difference of vector impedance between the "damped" and "free" conditions, such that, when plotted in polar coördinates, over a suitable range of alternating-current frequency, gives rise to a "motional-impedance locus," which locus is approximately circular, and is known as its "motional-impedance circle."

The motional impedance circle of a telephone receiver affords valuable material for determining the principal mechanical and electrical constants of the instrument.[1]

In the theory of the motional-impedance circle, as hitherto published, certain phenomena have been left out of consideration for the sake of simplicity; and especially that component of alternating magnetic flux passing through the coils which is due to the displacement of the diaphragm from its zero position when freely vibrating. The result has been that the motional-impedance circle failed to reveal the power expended parasitically (by both hysteresis and eddy currents) in the magnetic circuit. This defect in the theory has already been pointed out by Eccles.[2]

It is the object of this paper to supply the above-mentioned omission, and thus to offer a closer approximation between the theory and the observed behavior of the telephone receiver as an electromagnetic motor. It should be pointed out, however, that the theory here presented is still far from being complete, and that much more work, both theoretical and experimental, remains to be executed, analyzed and reported, before the theory can be regarded as satisfactorily established.

Limitations of the New Theory. The following limitations should be noted in regard to the stage of attainment aimed at in the theory here presented.

1. The alternating current supplied to the receiver is of small amplitude, and of single frequency; so that the magnetic flux passing through the coils and polar surfaces may be regarded as a normal permanent flux, plus a small sinusoidal variation. All the alternating mechanical, magnetic and electric quantities, are therefore assumed to be simple harmonic functions of the time.

2. Throughout the range of frequency considered, the flux in the magnetic circuit of the coils retains the same magnitude and phase with respect to the constant exciting alternating current. This means that the influences of magnetic skin effect and hysteresis in the magnetic circuit remain substantially constant.

3. The proportional effect of a small increment of m.m.f. in the magnetic circuit, due either to a small increase in exciting current, or to a small diminution in air gap at the poles, shall be the same, both in magnitude and in phase.

4. That over the range of frequencies considered, the "force-factor" A, the "equivalent mass" m of the diaphragm, the "mechanical resistance" r of the same, and the "stiffness coefficient" s, remain substantially constant.

The theory is presented with relation to a series of impedance measurements already published[3] on a particular bipolar Bell receiver *"C"*; so that these measurements offer, in a particular case, a check upon the application of the theory.

Magnetic Circuit and Vibrating System. In Fig. 1, it is assumed that the two poles N and S are permanently magnetized, as though under the action of a constant-current magnetomotive force F_0 gilberts. Under the influence of the permanent magnetic flux Φ_0 maxwells in the magnetic circuit, the diaphragm becomes flexed from its horizontal plane position and comes to rest at a certain zero position at the same distance from each pole. Since vibrational displacements occur on each side alternately of this reference position of rest, we may reckon a displacement therefrom of x cm. towards the poles as positive, and away from the poles as negative. The total number of turns on both coils together, is taken as N. The active surface of each pole, or of the diaphragm opposite thereto, is taken as S sq. cm., and since the polar gap is small by comparison with the linear dimensions of this surface, we may neglect

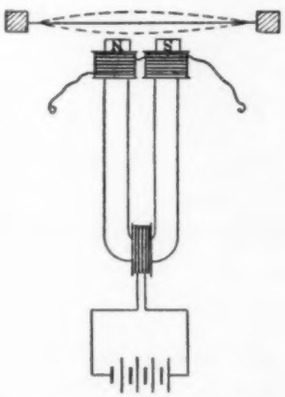


Fig. 1.—Simplified Magnetic Circuit of Bipolar Receiver.

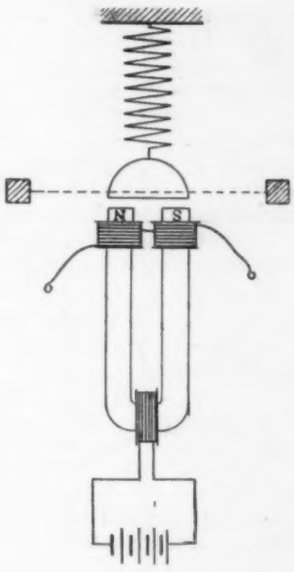


Fig. 2.—Simplified Mechanical System of Bipolar Receiver.

[1] Bibliography, No. 9.
[2] Bibliography, No. 24.
[3] Bibliography 17, pp. 442-428 and 449-450.

In Fig. 2, the mechanical vibration system is indicated as simplified into an equivalent mass m grams, under the retractive influence, so far as concerns alternating stresses, of s dynes per cm. of displacement. The frictional resistance force of this system to motion is taken as simply proportional to the velocity of displacement; so that is x represents the velocity $\frac{dt}{dx}$ of the mass m, *the retarding force is* $-r\,x$ dynes, where r is the mechanical resistance of the mass in dynes per unit velocity, or dynes per kine.

The simplification in the vibrational system represented in the transition from Fig. 1 to Fig. 2 seems justified from experimental results.

Magnetomotive Force Damped and Free. When the diaphragm is damped, or prevented from vibrating, a simple alternating current of I r. m. s. absamperes will develop a corresponding simple alternating m.m.f. of F_i r.m.s. gilberts, in phase with I. This may be represented

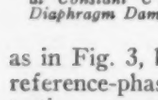


Fig. 3.—M. M. F. Diagram at Constant Current—Diaphragm Damped.

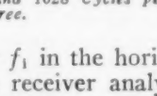


Fig. 4.—M. M. F. Diagram at Constant Current and 1028 Cycles per Sec. Diaphragm Free.

as in Fig. 3, by the plane vector f_i in the horizontal or reference-phase position. In the receiver analyzed, the testing current I was 0.000204 absamperes r.m.s., and taking the number of turns on the two coils together as 1300, the m.m.f. thereby produced would be

$$4\pi \times 1300 \times 0.000204 = 3.334 \text{ gilberts r.m.s.}$$

This is represented, to a scale of 1.0 gilbert per linear cm. in Fig. 1, as a vector 3.33 cm. in length.

When the diaphragm is free, or allowed to vibrate, the same exciting current will produce the same m. m. f. as before; but a new periodic m. m. f. will be developed in the magnetic circuit, owing to the periodic change in diaphragm displacement, and length of airgap; so that the reluctance in the circuit of the permanent magnet will be periodically varied accordingly.

Let F_0 = the m. m. f. of the permanent magnet (gilberts)
R_0 = the reluctance in the permanent magnetic circuit (oersteds)
Φ_0 = the magnetic flux across the airgaps in the circuit (maxwells)

Then in the magnetic circuit of the permanent magnet, there will be a permanent magnetic flux which, neglecting magnetic leakage through the surrounding air, will be

$$\Phi_0 \frac{F_0}{R_0} \qquad \text{maxwells (1)}$$

If the diaphragm is now caused to vibrate, by reason of independent variations of this magnetic flux due to alternating current in the coils, the reluctance in each airgop of area S sq. cm. will be varied by $-\frac{dx}{S}$ oersteds, if dx is the displacement of the diaphragm from its normal position, towards the pole; so that the total change in reluctance will be $-\frac{2\,dx}{S}$ oersteds.

But differentiating (1)

$$\frac{\because \Phi_0}{\because R_0} \div -\frac{F^0}{R_0^2} \triangle -\frac{\Phi_0}{R_0} \qquad \begin{matrix}\text{maxwells}\\ \text{oersteds}\end{matrix} \quad (2)$$

or $$\vee \Phi_0 < -\Phi_0 \frac{\square R_0}{R_0} \qquad \text{maxwells (3)}$$

but $\triangle R \triangle -2\triangle x/S$; so that

$$\triangle \Phi_0 \triangle \Phi_0 \frac{2\triangle x}{S R_0} \triangle B_0 \cdot \frac{2 < x}{R_0} \qquad \text{maxwells (4)}$$

This ifferential change in the flux through the magnetic circuit is such as would correspond to the action of a certain differential impressed m. m. f. $\triangle F_0$, such that

$$\frac{\because F_0}{R_0} \div \Phi_0 \qquad \text{maxwells (5)}$$

Consequently, substituting in (4)

$$\div F_0 \div B_0 \cdot 2 \times x \qquad \text{gilberts (6)}$$

If, then, we know β_0, the normal mean flux density across the airgaps, an alternating displacement of ∂x cms, r. m. s. towards the poles at reference phase, will generate an equivalent vector m. m. f. according to (6) in Fig. 4 by the plane vector F_x. The phase of F_x with respect to F_i cannot be assigned until we know the phase of the diaphragm displacement ∂x, but means for determining this phase difference will be indicated later on. The locus of F_x is indicated in Fig. 4. It is a "displacement-admittance" locus. At a vevy low frequency, F_x would occupy the plane-vector position $O\ a$. At a very high frequency, it would disappear towards $O\ c$. It would, therefore describe the locus $a\ b\ c$ in the direction of the arrow.

The resultant m. m. f. in the circuit is the planevector sum of F_i and F_x, and is indicated in Fig. 4 by F. At low frequencies, the size of F exceeds the size of F_i; but towards higher frequencies, the size of F falls below that of F_i. The effect, therefore, of the vibration of the diaphragm is to change the constant impressed a-c. m. m. f. F_i to a correspondingly varied m. m. f. following the vector locus $e\ f\ g$, as the frequency is changed.

In Figs. 3 and 4, the vectors represent, the scale,

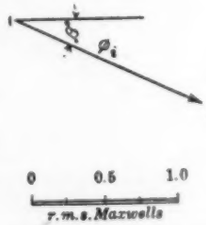


Fig. 5.—Flux Diagram at 1028 Cycles per Sec. — Diaphragm Damped.

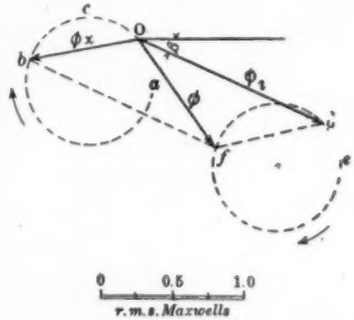


Fig. 6.—Flux Diagram at 1028 Cycles per Sec. — Diaphragm Free.

the approximate values of F_i, F_x and F, as derived from experimental tests of the selected instrument.

Magnetic Flux, Damped and Free. In Figs. 5 and 6, the planevector alternating magnetic fluxes are represented with the diaphragm damped and free. When damped, as in Fig. 5, the alternating m. m. f. of F_i r. m. s. gilberts at reference phase, produces an alternating magnetic flux of ϕ_i r. m. s. maxwells, lagging in phase $\beta°$ behind the m. m. f. The reason for the lag is partly on account of magnetic hysteresis, and partly on account of

magnetic skin effect. This angle $\beta°$ (25.3 deg. in Fig. 5) can be determined from the observed motional-impedance diagram, on the assumption already made that β is half the depression angle of the motional-circle diameter. In certain cases, β is found to exceed 54 deg. although it is, more commonly in the neighborhood of 30 deg.

In Fig. 6, on the assumption already made that the lag $\beta°$ is the same to both F_i and F_x; *i .e.*, that ϕ_x lags$\beta°$ behind F_x, we obtain the fluxes ϕ_i and ϕ_x with their resultant ϕ, as well as the approximate loci over which they travel under change of impressed frequency, β being taken as substantially constant over that range.

Actual observation shows that the angle of lag β_1 between F_i and ϕ_i is not, in general, identical with the angle of lag β_2 between F_x and ϕ_x, but their sum is 2 β, and the discerpency is here neglected.[4]

Electromotive Forces, Damped and Free. Fig. 7 shows the alternating e. m. f. planevector diagram when the diaphragm is damped. With constant exciting current I r. m. s. absamperes, and constant assumed resistance R_1 absohms in the winding, the vector $I R_1$ r. m. s. volts, expended in overcoming the winding resistance, will theoretically remain constant at all frequencies. The voltage expended in overcoming the rectance of the winding will be $I X$ r. m. s. volts, at a leading slope of $90 - \beta°$; because this voltage must be in leading quadrature to the flux ϕ_i. The resultant voltage $I Z$ is that which must be applied to the terminals of the receiver, in order to maintain in its winding the required constant current strength I. The locus of the impressed voltage $I Z$ on the preceding assumption, will therefore be the straight line $a\ b\ c$. The inductive voltage or voltage expended in overcoming the counter e. m. f. of induction is $a\ b$ on the diagram and is expressed by $j\ I\ \mathfrak{L}\ \omega$ abvolts $\angle$, where $\mathfrak{L}$ is a vector inductance of slope $\wedge\ \beta°$ as defined by the relation

$$\mathfrak{L} = 4\pi N^2 P \qquad \text{abhenries } \angle \quad (6a)$$

where P is a vector permeance expressed in maxwells

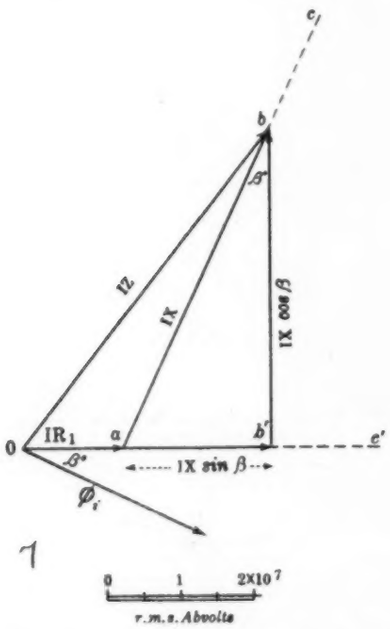


Fig. 7.—E. M. F. Diagram at 1028 Cycles per Sec.—Diaphragm Damped.

per gilbert $\angle$, or 1/oersteds $\angle$. The corresponding apparent resistance voltage $O\ b'$ traversing the locus $a\ b'\ c'$. The apparent reactance voltage is $b'\ b$. This apparent reactance voltage, as obtained from impedance measurements with damped diaphragm, is

$$I\ |\ X\ |\ \cos\beta = I\ |\ \mathfrak{L}\ |\ \omega \cos\beta \qquad \text{abvolts} \quad (7)$$

Here the symbol $|\ \mathfrak{L}\ |$ denotes the size of $\mathfrak{L}$ as a scalar.

The apparent inductance $\mathfrak{L}$ of the winding should also remain constant. Actually, observations show that the apparent inductance diminishes as the frequency is

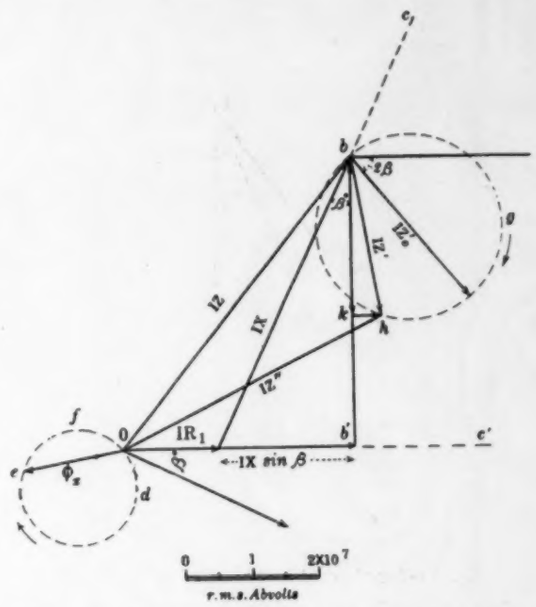


Fig. 8.—E. M. F. Diagram at 1028 Cycles per Sec.—Diaphragm Free.

increased, owing to the influence of changes in magnetic skin effect, which are assumed to be negligible in the stage of telephone theory here aimed at.

Fig. 8 represents the corresponding planevector e. m. f. diagram, with diaphragm free. In this diagram, the additional periodic flux ϕ_x, taken from Fig. 6, is included, and runs over the locus $d\ e\ f$. The vector impressed voltage $I\ Z''$, travels over the straight line locus $a\ b\ c$, as in Fig. 7; but at its end, there is added an e. m. f. locus due to the time variation of ϕ_x, which is a circle $b\ g\ h$. This circle moves parallel to itself, along the lengthening line $a\ b\ c$. The vector $b\ h$ is in leading quadrature to ϕ_x, in the position Oe, and represents the motional impedance voltage $I\ Z'$ at this frequency, or the voltage expended in overcoming the displacement e. m. f. of the diaphragm considered as a motor element. The e. m. f. $I\ Z''$ which must be impressed at receiver terminals, in order to maintain constant curent I, is represented by $O\ h$ abvolts. The component $O\ h'$, is the cophase component of e. m. f. and $b'\ k$ the quadrature or reactive component.

Impedances, Damped, Free and Motional. Figure 7, the damped voltage diagram, might also serve as an impedance diagram, if its various vectors are divided by the constant current I, and if, therefore, these vectors are read off to an appropriate scale of absohms. In Fig. 9, the transition is made, however, to a convenient resistance scale. The apparent resistance is $O\ b = R_1 + |\ X\ |\ \sin\beta$ absohms, the apparent reactance $b'\ b = |\ X\ |\ \cos\beta$ absohms, and the impedance with damped diaphragm

$$Z = O\ b = R_1 + |\ X\ |\ \sin\beta + j\ |\ X\ |\ \cos\beta = R_1 + X \text{ absohms } \angle \qquad (8)$$

As the impressed frequency increases, the impedance travels the locus $a\ b\ c$. In Fig. 1 of the paper referred

[4]Bibliography 18.

to, (Bibliography 17), the vector damped impedance locus makes an angle of $\beta = 25.°3$, very nearly, with the reactance axis, between $f = 700 \backsim$ and $f = 1500 \backsim$.

Fig. 10 shows the corresponding impedance of the instrument with the diaphragm free. The vector $O\ b$ pursues the same path $a\ b\ c$ as in Fig. 9; but at its end, there is added a traveling circular locus $g\ h\ k$. The impedance

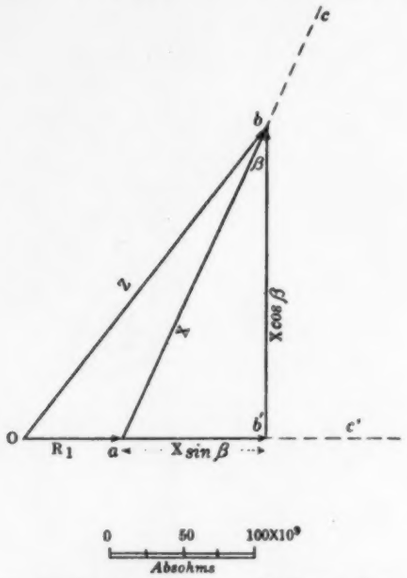


Fig. 9.—Impedance Diagram—Diaphragm Damped.

of the instrument is Z'', and we have the vector relation.

$$Z' = Z'' - Z \qquad \text{absohms} \angle \quad (9)$$

The vector path of Z', plotted separately, is the stationary circle $b\ g\ h$, and this circle is obtaned from experimental observations at constant current. It passes through the origin of co-ordinates like the circle of Fig. 27. It has a diametric depression angle, or lag angle, of $2\ \beta$, because the diameter being produced at reasonant frequency, the displacement velocity x of the diaphragm is then in phase with the flux ϕ_i, which is $\beta°$ behind the current, and the displacement x is then in lagging quadrature with the velocity of $(90° + \beta)$ behind the current. But ϕ_x is $\beta°$ behind the displacement x (Fig. 6) and is therefore $90° + \beta°$ behind the velocity x or $90° + 2\ \beta°$ behind I. The e. m. f. $I\ Z'$, Fig. 8, due to the variation of ϕ_x, being in leading quadrature therewith, is then $2\ \beta°$ behind I, and Z', at resonance, is thus $2\ \beta°$ behind the reference phase, or resistance axis.

Every telephone receiver has its own particular motional impedance circle, which is very sensitive to changes in temperature or in mechanical adjustment. Motional impedance circles differ:

1. In their size, or diametral length.
2. In their depression angle $2\ \beta$.
3. In the distribution of frequencies around the circle. Sharply resonant instruments will pass from the lower quadrantal frequency f_1, to the upper f_2, over half the circle, with a change of only a very few cycles per second. On the other hand, bluntly resonant instruments may require a change in frequency of several hundred cycles per second, to pass over the same range of locus.

Having found by observation the depression angle $2\ \beta$ of the motional impedance circle, the angle β is known, and the construction of Figs. 9 and 10 may be carried out, with the angle at $b\ b'$ made equal to β. Knowing the apparent resistance $O\ b'$, and the apparent reactance $b'\ b$, at various impressed frequencies, as well as $\beta°$; we can readily compute R_1 *and* £ from (7) and (8). R_1 should theoretically be substantially constant under the assumption that £ is constant. For the instrument here considered, the following Table gives the values of R_1 as computed from the observed resistances with damped diaphragm, and the angle β assumed constant at resonant value.

Frequency cycles per sec.	Angular Velocity rad. per sec. ω	Measured Resistance absohms at 20 deg. cent. R	Active component of inductive resistance $Rh = \omega L_0 \sin \beta$	Reactive component of inductive resistance $X = \omega L_0 \cos \beta$	$R_1 = R - Rh$ absohms
0	0	86.7×10^9	0×10^9	0×10^9	86.7×10^9
429	2694	124 "	41.9 "	89 "	82.1 "
702	4420	145 "	68.8 "	146 "	76.2 "
923.4	5801	162 "	90.5 "	191.5 "	71.5 "
*1015	6378	168.4 "	99.5 "	210.5 "	68.6 "
1306	8202	189 "	128 "	270.7 "	61 "
1507	9460	204 "	147.6 "	314.1 "	56.4 "

*Resonant frequency.

the steady apparent fall in the values of R_1 as the frequency was increased, may be attributed to the influence of changes in magnetic skin effect here neglected.

Electric Power Damped and Free. With the diaphragm damped, the vector diagram of either Fig. 7 or Fig 9, might serve as a power diagram, if read off to a corresponding scale of abwatts, or ergs per second. The power diagram is repeated, however, in Fig. 11 to a convenient power scale. $O\ a$ is active power, $I^2\ R_1$ abwatts, expended in heating the winding. $I^2\ X$ is the vector power $a\ b$, expended in the magnetic circuit. It follows the locus $a\ b\ c$, as the frequency is varied. The active component $a\ b' = I^2\ |X|\ \sin \beta$, is dissipated thermally in the magnetic circuit, in hysteresis and eddy currents. The reactive component $b'\ b = I^2\ |X|\ \cos \beta$ is utilized in alternately storing and releasing energy in the magnetic circuit.

When the diaphragm is freed, the power conditions

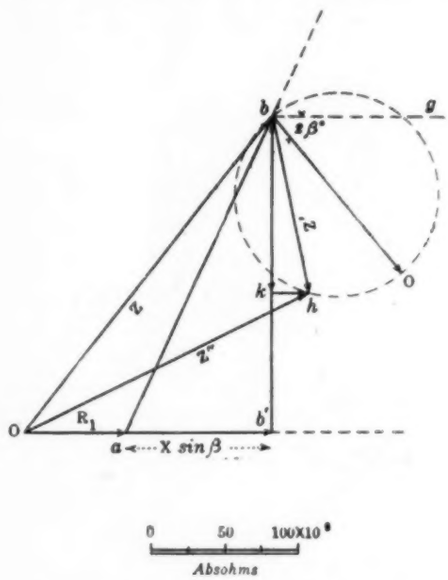


Fig. 10.—Impedance Diagram—Diaphragm Free.

are indicated vectorially in Fig. 12. $O\ a$, as before, is the thermal power $I^2\ R_1$, dissipated in the winding. The power delivered to the magnetic circuit is $a\ h$, which is in leading quadrature to the resultant flux ϕ, see Fig. 6 The active component $a'h'$ includes the power expended

in hysteresis and eddy currents, and also the active mechanical power delivered from the magnetic circuit to the diaphragm. The reactive component h' h includes power utilized in storing and releasing magnetic energy in the magnetic circuit, and also power utilized in storing and releasing reactive mechanical energy in the diaphragm.

Mechanical Velocity, Damped and Free. When the diaphragm is damped, the vibrational velocity of displacement must be zero. When, however, the diaphragm is free, the velocity of displacement x will have a definite magnitude and phase. If we assume the vibromotive force $f_i = Og$ r. m. s. dynes, Fig. 13, to remain constant at all frequencies, the locus of the vector velocity x will be the circle $O\,a\,b\,c$. This mechanical relation has its complete electric analogy in the simple alternating-current circuit of Fig. 14, where a simple harmonic e. m. f. E, of constant r. m. s. magnitude, and at standard phase, supplies the simple circuit $C\ R\ L$ at successively varied frequencies. All of the resistance of the circuit, assumed constant, is located in the resistor R, all of the inductance in the inductor L, and all the capacitance in the condenser C. At a very low frequency, the impedance of the circuit will be large and entirely due to the condenser C. The alternating current will be very feeble and will lead the impressed e. m. f. by 90°. As the frequency is raised, impedance diminishes, both in size and in slope. The current strength will therefore increase in magnitude, and come more nearly into phase with E. As is shown in Fig. 15, when the resonant frequency of the circuit is attained, the curent will be a maximum at I_0, and will be in phase with E. Finally, as the frequency becomes very high, the current will disappear, and lag 90° behind E. The locus of the vector curent will be the circle $O\ a\ b\ c$, Fig. 15. If, in the mechanical system of the diaphragm, the equivalent mass replaces the inductance L, the stiffness s of the diaphragm, replaces $1/C$, and the mechanical resistance to motion r replaces R; also the vibromotive force f_i replaces E; then the vibrational velocity x will correspond both in magnitude and phase to the alternating current strength I. The phase lag α of the velocity is then equal to the slope of the mechanical impedance.

$$r + j\,(m\,\omega - s/\omega) \qquad \text{mechanical ohms } \angle$$

Mechanical Displacement. The mechanical displacement of the diaphragm at elongation corresponds, in the electrical system of Fig. 15, to the displacement of electricity at cyclic elongation. It is represented in Fig. 16 by the vector $O\,c$. This vector is in lagging quadrature to the vector $O\,c$ of Fig. 13, at one and the same impressed frequency. The locus of x is the displacement curve $a\,b\,c\,O$.

(To be continued.)

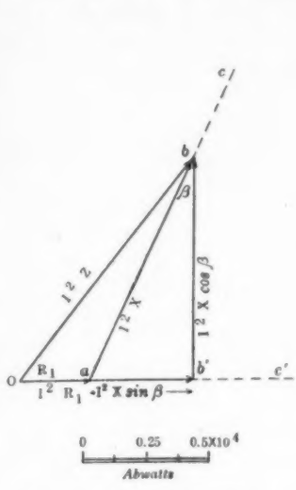


Fig. 11.—Electric Power Diagram—Diaphragm Damped.

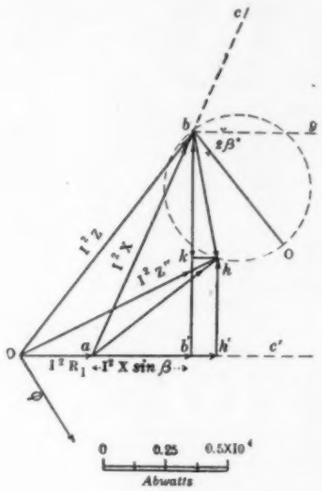


Fig. 12.—Electric Power Diagram—Diaphragm Free

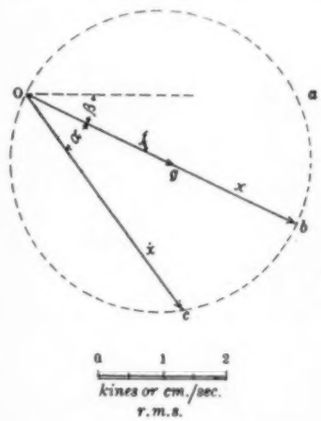


Fig. 13.—Velocity Diagram—Diaphragm Free—Constant V. M. F. and Varied Frequency.

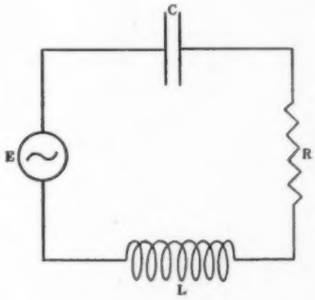


Fig. 14.—Simple Alternating Current Circuit Under Constant E. M. F. and Varied Frequency.

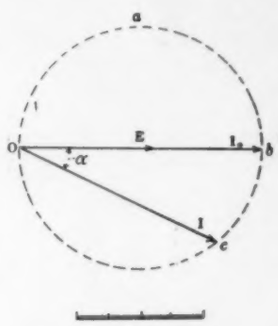


Fig. 15.—Current Diagram in Simple A-C Circuit, Under Constant E. M. F. and Varied Frequency.

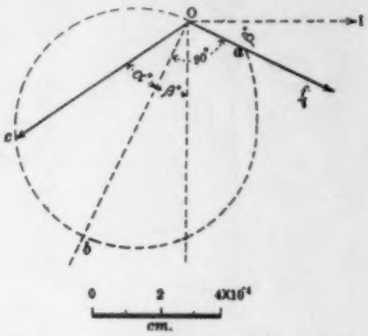


Fig. 16.—Displacement Diagram—Diaphragm Free.

Chicagoans Talk Competition

Plans for a competitive telephone company for Chicago as a means of forcing down existing rates have been receiving serious consideration from the council committee on gas, oil and electric light, according to a statement by Ald. Thomas J. Lynch, chairman of the committee.

"The present situation may develop into invitations being extended to Independent companies to come into the Chicago field," said Ald. Lynch. He hinted the engaging of William H. Crum, telephone engineer, recently to aid Mr. Cleveland in his fight against the Chicago Telephone Company was in accord with the plans to invite Independent companies into the Chicago field.

"Mr. Crum, I have learned, is a high-class engineer and he knows the telephone business from a to z," said Ald. Lynch. "He installed Independent systems in Hot Springs, Ark., and other cities. I may take the matter up with him at an early date.

"An Independent company need not try to compete with the Bell people for long distance service. It will find the local business entirely sufficient."

English Telephone and Telegraph Service

Report of the Postmaster General of Great Britain

WHEN the National Telephone Company was running England's wire system it had a total capital of some $55,000,000, on which the average dividend for five years before the transfer to the state was 5.13 per cent. In 1913-14, after the service had been transferred, it shhowed a profit of $1,195,000, in addition to the interest charge of $3,460,000. These two figures gave a dividend of 4.29 per cent, on the total capital employed. The National Telephone Company paid in royalties to the Post Office 10 per cent of the gross receipts, and in the last year of working that amounted to $1,775,000. In the company's last year it provided $65,000 for pensions, and that sum was increased when the service was taken over, to $1,215,000 per annum, and salaries and wages by $790,000 a year. The royalties payment of $1,775,000 was more than set off by the additional wages and pensions, which amounted to $2,000,000 a year. The plant, too, was run down, and it had been very expensive to keep it in anything near working state, while the future would call for a heavy capital outlay in order to bring it to a satisfactory state of efficiency. By degrees, on account of the war, the cost of living increased and the pensions and the rate of wages paid to the telephone workers had been increased. It began in 1915-16, with $885,000, and this year it was $12,500,000 per annum more than when the service was taken over. That meant that the wages bill had practically doubled since 1913-14. Over and above all that provision had had to be made for the pension liability, which had increased concurrently with the rise in wages. The renewal of the plant would also be very much more expensive, and consequently the cost of new construction and the extension of the system must be very much higher. An exchange costing $500,000 before the war would now cost more than double. Towards the extra expense, all that had been done was in 1915 to transfer to the public a charge of $2,500,000 a year. The present position was that the increased cost of the services came out at between $12,500,000 and $15,000,000. Consequently, it was obvious that the service must either be run at a loss, and so become a charge on the taxpayer, or the charges must be increased to the public, declared the British postmaster general in a report to the House of Commons. All commercial undertakings had increased their charges, and he did not see why the charges should not be increased. He was having schemes prepared, and when they were ready he proposed to come to the House and ask for a select committee to advise upon them.

He had difficulties in maintaining an experienced staff during the war. At the time of the armistice over 800 were employed in the various government department, and now the number was over 700. The supply recruits was improving and not so many were leaving; and gradually he hoped to get more efficiency. The average number of daily calls about the time of the armistice in London was between 900,000 and 1,000,000, and this had increased now to over 1,250,000 per day. That meant they had got a much heavier load to handle by a less experienced staff. He deprecated the languge used by some of the subscribers over the telephone to the girls.

EXTENSION WORK

Construction work had been suspended for nearly five years. In London there was a great shortage of underground cables, and this year he proposed to spend $1,250,000 in laying extra cables. That would not relieve the whole of the congestion until new buildings were ready or present ones extended, and the switchboards extended. The first extension—a new exchange—would be in operation towards the end of the year. It would be called "Clerkenwell" and would relieve "Avenue" and "London Wall." Immediately that was ready they would be able to take 1,700 subscribers, which would afterwards be increased to 7,000 The Avenue, Victoria and Hop exchanges would be extended. New exchanges would be built on the site of the Inns of Court Hotel and at Bishopsgate and the Tower, and three more in the West End. In outer London seven new exchanges would be built and five considerably extended. In the provinces about $1,250,000 was being spent in laying underground cables in over 20 towns. In Huddersfield a new exchange has been completed and was working very satisfactorily. There would be eight new exchanges this year, and extensions to seven existing exchanges. The principal item was a new underground trunk line from London to Manchester, via Northampton, Leicester, Loughborough and Derby; and from Derby to Sheffield and Leeds. That was a very big undertaking, which he was afraid would not be completed for about 18 months. Eight underground telephone cables and 60 overhead circuits would be begun this year. The total cost of the work would amount to some $15,000,000; about $5,000,000 would be spent this year, in addition to $10,000,000 on exchanges and local works. There would be a good deal of delay owing to the difficulty of getting material, and the engineers were still in the army to the number of 3,000 or 4,000. During the war the trunk lines had been taken over by the fighting services—342 in all, which were now reduced to 112. A multiplex telephone system had been introduced enabling several people to telephone in each direction over the same wire at the same time. He hoped to be able to get messages over the same wire in each direction, but the system was in an experimental stage. He did not think the telephone system had really had a fair chance in England. The National Telephone Company naturally was not going to spend large sums of money, and development had only just begun when the war started, and it was followed by another five years of neglect. Since the armistice they had, however, put in over 60,000 telephones.

SUBMARINE CABLES

Cables were not, strictly speaking, under the government, but they had always worked hamoniously with the companies. The cables generally were showing rather less delay, except for Egypt and Australia. They were suffering from too much traffic and from frequent interruption. In addition there was the cessation of work which went through Germany and Russia, where the cables had naturally not been used since the war began. Under ordinary conditions the capacity of those cables was 253,000 words per day, but on account of interruptions and various other troubles, their

capacity had been reduced to 167,000 words. Government traffic was 18 times more than it was before the war, and it was now occupying 25 per cent of the total capacity of the eastern cables. The censorship of cables would be abolished as from midnight on the 23rd inst. That would allow the introduction of private codes and a consequent decrease of between 20 and 30 per cent in traffic. The companies were doing everything in their power to improve their service and make is as efficient as possible.

In the course of the discussion which ensued, Capt. J. C. Denison Pender mentioned among the causes of the delay the fact that the enemy submarines had led many communications to be sent over the cables which before the war were normally sent by post. The suppression of the private codes had also incerased the traffic over the lines. Then there had been a great influx of cablegrams sent home by the men who had come to fight for us from all parts of the world, and the submarine menace had hampered the repair work on the cables and make it very difficult. The question of government traffic was the most serious of all. Twenty-five per cent of the traffic being carried by the companies at the moment was due to government work. He wished pressure could be brought to bear on the departments concerned, end especially the war office, who had had the power in their hands so long that they thought they could go on without any restrictions being placed on them. The renewal of cables had been absolutely impossible during the last five years, but he hoped by the end of August all the existing cables would be in fair working order, and in October they expected to lay a new cable from this country to Gibraltar, and gradually to extend it round the Mediterranian through Aden and on to Singapore.

Fostering the Telephone Industry

From "The Electrician" of London, England

The position of the telephone industry in England differs very materially from that of other industries in that there is only one customer of any magnitude, namely, the Post Office. Consequently, the well being of the industry must depend very largely upon the attitude of the Post Office authorities. To a large extent a similar position holds in most other countries, because the telephone system is generally a monopoly. Perhaps the position in America is of the greatest interest to us because the idea has got abroad that American practice leads in telephonic matters. In some respects this may be true, because the conditions have been such as to permit of very large developments in the United States. When, however, we come to the solution of problems which concern us more particularly in this country, our telephone engineers have a record of which they have no reason to be ashamed. There is no doubt that when it has been necessary to tackle special problems our engineers have equalled, and in some respects surpassed, American achievements. As examples, we may call to mind the loaded submarine telephone cables, which were worked out practically in this country without other experience from which to draw. Then again, there are the balanced circuits of the London-Liverpool trunk telephone cables. Further, it may be said that the experimental automatic exchanges in this country are more highly eveloped than any others in the world, although they may not be on so large a scale.

Now the position in the United States is largely due to the close relationship existing between the main customer on the one hand (namely, the American Telegraph and Telephone Company) and the main manufacturer (the American Western Electric Company) on the other. The Western Electric Company can well afford to carry out costly development work when it is practically certain that such work will be used commercially and, therefore, to its profit.

In the United Kingdom the position is very different because here, on the one hand, we have state enterprise as virtually the only customer, and it is impracticable for the state to have an ordinary commercial working arrangement with manufacturers. On the other hand, as manufacturers we have not merely one company but several. It may be advantageous that there should be several manufacturers, for this leads to competitive effort; but all such efforts are liable to be sterilized if they are not supported or encouraged adequately by the state. Although there cannot be anything in the nature of a working arrangement, we suggest that the Post Office might very well encourage manufacturers to a greater extent than has been done hitherto. If the Post Office shows an inclination to purchase apparatus of American type there is little inducement for our manufacturers to risk the cost of development in various directions, for the simple reason that supposing the British Post Office rejects the idea there is no other customer in the country to consider it. It should be possible for the Post Office to trust its engineers and to let them co-operate with those of the British manufacturing firms, new methods and new plant being taken on their merits and independently of American developments. A leaning towards American plant not only tends to stifle British developments, but it leads to the risk of having to pay royalties or monopoly prices for such plant. Although it may be possible for the Post Office to stipulate in such cases that the plant shall be manufactured in this country, and even to call for the abandonment of patent rights, yet this does not improve the position of the British manufacturer. It is highly desirable that the latter should have the advantage of supplying the home market if he is to make satisfactory progress in export trade. For in telephone manufacture, owing to the enormous amount of detail, it is most uneconomical for a factory to attempt two widely differing types of product, one for home and the other for export. If the Post Office would adopt a policy of co-operation with the British manufacturer any difficulty arising from a monopoly would be avoided, and, we may feel assured, that equipment would be secured which is best suited to British requirements.

In conclusion, we may remark that the subject at the present moment is of very considerable importance. Owing partly to the progress in development and partly to changes in the economic position during the last five years, an enormous demand for automatic telephone equipment has now arisen. The demand is not limited to this country. Australia has already made much progress in this direction; in South Africa a decision has been made in favor of automatic telephones: even in India and in the eastern parts of the Empire a similar demand is arising. Italy has already begun the reconstruction of the telephone system on the automatic principle in every large city; and, lastly, automatic telephones are under careful consideration for London. It is, therefore, highly desirable that the Post Office should adopt such an attitude as will enable the British manufacturer to take his proper place in the markets of the Empire and of the world generally. We do not suggest that American apparatus should be excluded, but there is a difference between friendly rivalry and slavish imitation.

The Operator versus the Automatic

Paper Read at a Meeting of the London (England) Telephonists' Society

By H. C. TOWNSEND*

WE are introducing this subject without any feelings of antagonism towards the automatic switchboard, but with a full appreciation of its wonderful success, and the marvelous ingenuity shown by its inventors. We have in mind, however, that in these rapidly advancing times, the old is being quickly replaced by the new, and automatic switchboards are taking the place of manual switchboards. Also the novelty of a new undertaking often casts a shadow over an old one.

We often notice that it is not until the music of the dead march has ceased and the last traces of the funeral have disappeared, that good words are said about the services rendered persons who have passed away or things that have ceased to exist. A distinct proof of this forced itself upon our notice a few years ago when the undying fame of a great telephone company, which has passed away, was constantly dinned into the ears of the postmaster-general. The postmaster-general stated at the time that he felt like a man who had married a widow, and was constantly hearing about the virtues of her lost husband. I doubt whether such eloquent praises of the late National Telephone Company were heard before December 31, 1911, although you will understand that our imagination is quite equal to the occasion.

In consequence of these facts, it behooves us to sound a note of appreciation concerning the wonderful services rendered with the aid of the manual switchboard. It has been of immense value in many countries of the world, and has satisfied their demands for a number of years. It necessitates the presence of the human element in the form of a trained operating staff, and this fact is of great importance when comparing the working of the manual switchboard with the working of the automatic switchboard. The following instances will illustrate this fact:

If the transmission on certain circuits which are connected together is not good, and the subscriber advises his telephonist, she can soon change the cords or junctions and thus arrange for a better conversation. It might be said that the automatic switchboard can deal with this if the subscriber makes a fresh call, as he will probably be connected with different cricuits. It is, however, well known that during the busy hours, he would have to risk the engaged signal being connected, owing to the possibility of the subscriber's line or the junctions being engaged in the meantime. During the slacker hours of the day, he might be connected with the same circuits again.

The nursing of calls by the telephonists has always been of great value to subscribers, and the automatic switchboard is unable to arrange this. It often happens that a subscriber wishes to make a call while a visitor is present. If the number is engaged, and the telephonist eventually completes the call on her own initiative, the subscriber is saved the annoyance of repeatedly calling for the number itself.

In cases where as system has to deal with a flood of traffic, the operating staff and the manual switchboard are able to cope with it in a far better way than the automatic switchboard. A typical example of this is as follows: When certain football matches are being played numerous calls are made for the number of the telephone on a football ground. The callers wish to know how the game is progressing. On a week-day, when thousands of the usual spectators of the game are at work in the city, thousands of calls are made to this number during an hour or two. A far higher load has therefore to be handled at the exchange concerned than the one which can be coped with in the usual way.

It will be understood that with an automatic system, all the junctions to this exchange would soon be in use, and the majority of them would be connected with the busy signals. It would therefore be extremely difficult for other callers to obtain any other number on this exchange.

With the manual switchboard we are able to cope with the traffic. The "B" operator need not allot junctions for the number of the football club under such circumstances, but can reply to the distant exchanges on the order wire, repeating the number and adding the expression "busy" or "not answering" as the case may be. The "B" operator thus speaks to several distant operators at once, and avoids using valuable equipment unnecessarily. With this arrangement, callers for other numbers have not difficulty in obtaining them, and the flood of traffic can be dealt with very satisfactorily.

The breakdown of a large number of trunks usually produces the same effect as a heavy flow of traffic, as the traffic on the remaining trunks is too heavy for all the calls to pass over them. On a manual switchboard the operators could enlighten the subscribers by explaining that a break-down had occurred, and approximately the duration of the delays to which their calls would be subjected. The subscriber will then know whether it is advisable to send a telegram or other message.

With an automatic system the subscriber would be very much handicapped, as he would probably have as much difficulty in calling the information officers as he has in calling the number required.

In cases of emergency, the presence of the human element has saved the situation on many occasions. On one occasion a fire occurred at a subscriber's house. He went to the telephone and shouted "Fire" before he thought that the operator had time to answer his call. As the place became too hot for him, he immediately left the telephone to run to a fire-post. He was, however, astounded to meet the fire engine, and afterwards to see it stop in front of his house. He found out later on that the operator had heard him call "Fire" and had advised the Fire Brigade about it, and had given them his name and address. We will stand by his opinion that the human element is a great boon to subscribers, which they know very little about. We will go further than that, and say that the subscribers will know all about it when the full automatic switchboards take the place of manual switchboards all over the country.

*Assistant Traffic Superintendent, London Telephone Service.

On another occasion, a permanent signal was noticed on a picture palace line. It was very late on a Sunday night, but the night operator rang on the line in the usual way. He then heard some whispering, and the receiver was replaced. The night operator promptly advised the police, who went to the picture palace. The police found that the receiver had been knocked off the rest by burglars, apparently by accident, and that they had decamped, leaving their burglary tools behind, and the safe untouched.

On another occasion a signal was received on a line connected with an electric light station. When answering, the operator heard an exclamation and a remark by someone in distress. She knew that the manager of the station had a telephone at his residence, and at once rang him up and advised him. We afterwards learned that a serious accident had occurred at the electric light station, and the manager had arrived in time to avert a calamity.

Many such illustrations could be given to show the paramount importance of the human element in connection with telephone calls, especially when considering the subscriber's point of view.

We are naturally very interested in the automatic switchboard, and admire the subtle ways in which difficulties are overcome in dealing with the different varieties of traffic.

We look forward to the automatic switchboard as a means of solving some of the telephone problems of today, particularly with reference to staffing and engineering questions. Where a large number of operations have to be made of a similar kind, and have been standardized, the operator becomes a mere machine, and it is no credit to her intelligence to ask her to do such work, and it should be done by machinery. We maintain that as soon as any work ceases to require human intelligence and initiative at different times when the work is in progress, that work should be done by machinery, and we generally find that it is carried out in this way.

We might mention that the operation of a local call is a typical example of this class of work, and in some exchanges it seems very desirable that this work should be done by an automatic switchboard. The operator's services could then be employed more usefully on other work.

As time goes on, it is absolutely essential that the speed of telephonic communication should steadily increase, as the speed of all other means of communication is steadily increasing. It is a well-known fact that the process of "speeding up" is continually going on. We think that the automatic switchboard has come as a boon to operators, and will carry out a great deal of the necessary "speeding up," and also the monotonous part of the work.

To give you an idea of the rapidity of connection and disconnection, we made 10 local calls in succession in 80 seconds, which is an average of 8 seconds for each call, excluding a conversation.

The automatic apparatus works even more rapidly than these figures lead us to imagine. The automatic ringing machines ring the subscriber's bell for one second, and then cease ringing it for 3 seconds. It was necessary to wait one, two, or three seconds in some cases before the bell rang after the connections had been completed.

You will understand that the automatic system has overcome all the phonetic troubles which we are subject to with our manual systems in the way of wrong numbers. For instance, there is no possibility of our obtaining the wrong numbers 294, 394 or 354 when we are calling for 254.

It has been stated that wrong numbers are often received on the automatic system. Operators who operate automatic dials, have complained of wrong numbers being obtained (i. e., being connected with dead levels, dead numbers, dead circuits, etc.), without hearing the ringing on the line. Subscribers also complain.

An experiment has, therefore, been made in order to find out to what extent the apparatus is responsible for these. The label with the figures printed on it was withdrawn from the dial and a similar label was fixed to the revolving plate of the dial. This arrangement slackens the working of the dial slightly as the subscriber cannot see where to place his finger for the next figure to be dialed, until the revolving plate stops. This appears to be an advantage, as the subscriber may be dialing too rapidly; possibly he dials the next figure before the dial stops or before the automatic apparatus has completed its movements.

The interval between one set of impulses and another set is almost negligible when dialing rapidly This fact is particularly noticeable when the next figure to be dialed is a small one, such as 1, 2, or 3. Each set of impulses must be thrown by means of side switches from one electro-magnet to another during this interval. It is, therefore, thought that the subscriber sometimes dials faster than the apparatus works.

The experiment was made for two days on the incoming junction position of a switchboard dealing with calls received for automatic subscribers. Only four wrong numbers were obtained by the operator and the local engineer stated that the dialing was more regular, and the apparatus worked more steadily during this time.

This arrangement overcomes one or two difficulties which have been experienced with the usual marking of the dial.

It is thought that this alteration of the labels is the solution of the wrong number trouble. It apparently makes people dial more slowly and carefully. It is thought, therefore, that this marking might be arranged in connection with dials used by operators or subscribers when complaints of wrong numbers are received. The alteration could be a temporary one, as it results in some inconvenience owing to the dazzling effect of the moving figures. It could cease as soon as the operator or the subscriber had learned the correct rate of dialing and obtained more confidence in the automatic system.

We had previously satisfied ourselves that the majority of wrong numbers complained of were not due to the automatic apparatus. A record had been taken during several weeks by an operator stationed at an incoming junction position of a switchboard dealing with calls received for automatic subscribers. Her instructions were as follows: When an opportunity occurs dial the number very slowly and carefully. Then wait until the called subscriber answers. Then keep a record of O.K. calls and details of wrong numbers. One thousand nine hundred and twelve O.K. calls were thus recorded, and 2 wrong numbers, which were found to be due to faulty connectors.

It is therefore considered that if numbers are

dialed correctly and the automatic apparatus is maintained properly, the automatic system does not result in wrong numbers.

You will also understand that the automatic system is practically a secret one, and this fact suggests certain advantages, although we do not place much importance on this point.

Coin box calls, calls for spare numbers, lines out of order, etc., are dealt with at the answering positions. Calls for trunks or junction calls are dealt with at special trunk positions. The subscribers dial the figure "O" to obtain these positions.

The principle of the automatic switchboard, with its relays working step by step, is as old as the hills. In the days when the Red Indians were troublesome to settlers, a great military chief entered the Red Indian territory, and negotiated the conditions of a general peace with the chiefs of several tribes. A satisfactory settlement was reached at noon on a certain day, and by means of despatch riders he was able to advise his headquarters of the fact within two days. The Red Indians, by means of relays of smoke fires were able to advise all the tribes scattered over hundreds of miles before sunset on the same day.

Some prejudices against the automatic exchange have always existed, and it has been viewed with suspicion by the traffic staffs all over the world, who have been accustomed to the manual exchange. This is perhaps a natural result of all great changes. Similar prejudices and suspicions arose in connection with the state control of the telephone system, and we think that a parallel can be drawn between these two important changes of practice. Both the automatic system and the state control of the telephone system in England have some very old and well founded traditions to face, and will have to live up to the standards which have been set up during the past two decades. In either case, however, should the glories of the past cast a shadow over the expected glories of the future.

Telephone Patents Recently Issued

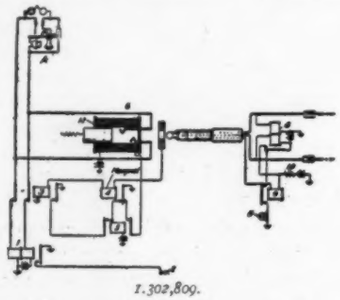
A Brief Digest of the Most Interesting Current Specifications

BY DAVID S. HULFISH

NO. 1,302,767. Signal Storing System. Issued to H. P. Clausen and C. L. Goodrum, assignors to Western Electric Company, Inc., New York, N. Y. The patent bears upon the transmission of signals from the automatic telephone to the selecting switches in an automatic telephone exchange, and provides a storage device for the signal sent by the telephone. After the storage device has operated, a current is sent to the calling line to indicate that the central office apparatus has responded to the numerical signal sent in.

1,302,808. Ringing System. Issued to C. W. Keckler, assignor to Western Electric Company, Inc., New York, N. Y. In a manual switchboard with commutator for ringing repeatedly until the call is answered, several commutators are provided so that one of them will be always ready to ring; with relays upon the ringing plug such that when the ringing plug is inserted into a jack it will be connected to that particular commutator which is at that instant ready to ring.

1,302,809. Plug-Ejector. Issued to C. W. Keckler, assignor to Western Electric Company, Inc., New York, N. Y. In a manual switchboard, the answering jack is provided with a magnet and plunger. In connection with the cut-off relay is a marginal relay which is operated when the called party hangs up his receiver after a connection, when immediately the magnet is energized



1,302,809.

and the plunger moves to strike the answering plug and to eject it from the jack.

1,303,056. Callsender System. Issued to A. E. Hague, assignor to Western Electric Company, Inc., New York, N. Y. In each series of impulses transmitted from the callsender to the exchange, the first impulses are not used at the selecting switch. An extra relay prevents the first impulse from reaching the switch.

1,303,351. Hook Switch. Issued to Ray H. Marson, assignor to Stromberg-Carlson Telephone Manufacturing Company, Rochester, N. Y. In a common battery telephone system, the first part of the hook-lever movement closes the line circuit to render the receiver effective, and the latter part removes a shortcircuit from the secondary of the local induction coil. Thus, by stopping the hook halfway, one may listen without disturbing the line with one's transmitter.

1,304,641. Linefinder System. Issued to S. B. Williams, Jr., assignor to Western Electric Company, Inc., New York, N. Y. When a linefinder switch has selected a calling line, an auxiliary switch selects an idle operator, and the linefinder switch then selects an idle trunk to the indicated operator.

1,305,981. Metering System. Issued to E. E. Hinrichsen, assignor to Western Electric Company, Inc., New York, N. Y. In this manual switchboard the cut off relay has two armatures, one of them operated by the insertion of the answering plug to cut off the line relay connections, and the other of them operated only by the metering key of the connecting cord-pair; the second armature then operates the meter and the meter closes a circuit to keep both armatures of the cut-off relay up until the completion of the connection.

1,306,406. Trunk Circuit. Issued to H. D. Currier, assignor to Kellogg Switchboard & Supply Company, Chicago, Ill. The trunk, in connection between two manual switchboards, is jack-ended at each end. A ringing relay is provided so that, when the trunk is rung upon at one end, the operator at the other end cannot connect her telephone until after the ring has ceased. Thus it is impossible for one operator to ring into the telephone of the other operator at the other switchboard.

Joplin Wants Mutual

Subscriptions were started for the obtaining of a mutual telephone system for Joplin, Mo., at a mass meeting held in the Chamber of Commerce offices August 4.

Calling of the mass meeting was decided upon at a suggestion of Mayor J. F. Osborne. The motion was made to attempt the obtaining of subscriptions for a mutual telephone plant in addition to the campaign then pending to obtain lower telephone rates and the committee in charge of the campaign was instructed to call the meeting.

Mayor Osborne said that a number of persons had signified their intentions of taking stock in the proposed company.

T. C. Tadlock, Fred BaSom and M. B. Davidson were appointed a committee to prepare legal blanks for the obtaining of subscriptions for stock. BaSom recommended that the company be capitalized at $75,000 or $100,000.

Meter and Coin Devices for Automatic

Read Before the Automatic Telephone Engineers' Conference in Chicago

By ARTHUR BESSEY SMITH*

TELEPHONE service, to be measured, must be understood. It is the affording of facilities for conversations between people who are too far apart to use the air alone to transmit speech. It is well to keep this simple statement in mind when we consider service.

Scientific rate making points to two charges for many things. The first is the charge for readiness to service, the second is the charge covering the cost of rendering the service. According to this, we should pay a grocer a monthly sum in addition to the amount paid every time a purchase is made. Such a manner of paying for service is not always possible, although it is done by co-operative associations when they make up deficits.

There are three measures for telephone service: (1) continuous availability; (2) time that apparatus is used, and (3) number of conversations held.

Continuous availability, whether conversations are held or not, is a service of great value. It is like the possession of articulate speech itself. A man may not talk every minute of the day, yet he would pay a great deal of money to be kept from becoming a deaf-mute. Just so, the presence of the telephone instrument in the

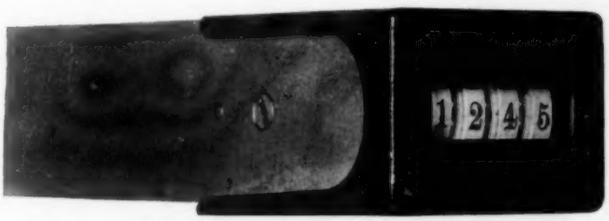


Figure 1. Central Office Meter

office or home, ready to use at any time, is worth a great deal.

FLAT RATE, UNLIMITED SERVICE

Charging solely for continuous availability is called "flat rate, unlimited service." It results in a large use of the telephone, and gets people to depending on it. This is just what a telephone company should want, and does want, if it does not cost too much.

The cost of automatic telephone service increases very little with increased use. The "stand-by" charge is practically all that there is to pay. Automatic telephony is the promoter of flat rates and the advantages which go with them.

Charging for the time used seems to be a fairly reasonable method of charging. It assumes that the cost of the service, or its value to the user, is proportional to the time that the apparatus is occupied. This is more nearly true as to the cost of automatic service than of manual service. It costs practically nothing to set up a call in an automatic switchboard. It is well known that in a manual switchboard this is the large item of expense.

Charging for service in proportion to the number of completed calls is the least reasonable and scientific of all. This is particularly true in automatic switching. In manual switching, it would be more correct if the subscriber had to pay for all calls, because those calls which find the called line busy or which are not answered, cost the operating company as much to handle as those which are completed.

MESSAGE RATE MOST GENERAL

The charge for completed calls is the most widespread in use and appears most reasonable to the pub-

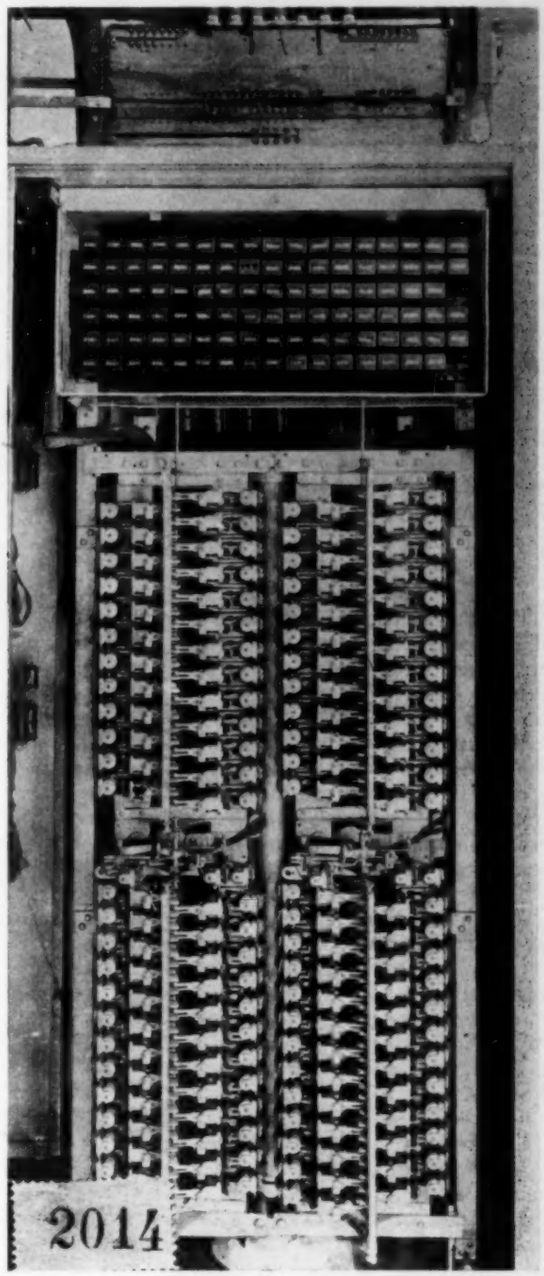


Figure 2. Line Switch Unit with Meters.

lic. They look upon buying a telephone connection much as they look upon buying a lead pencil or a street car ride.

The money spent for substation meters or coin boxes

would produce a better effect if invested in additional switches at the central office. The cost of 5,000 coin boxes will buy about 1,400 additional selectors, which would double the number of selectors in the average 5,000-line office. The cost of central office meters for 5,000 lines will buy about 680 additional selectors. This is a 50 per cent increase in selectors, which will

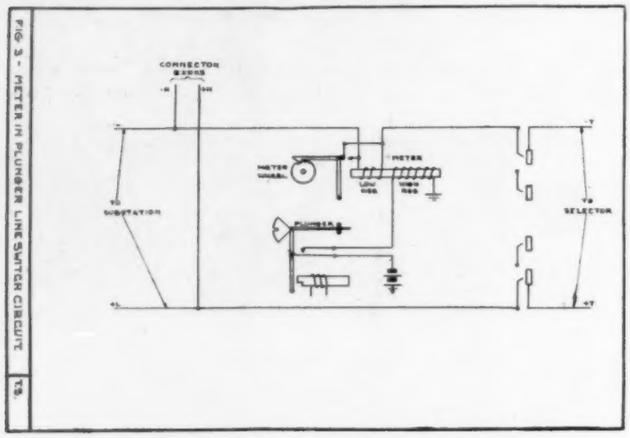


Figure 3. Meter in Plunger Type Line Switch Circuit.

carry at least 50 per cent more traffic; perhaps 60 per cent.

It seems to the writer that the popularizing of service is of sufficient value and importance to cause the investment of money in traffic carrying apparatus rather than in that which reduces traffic. It is acknowledged, however, that this fact has not gained full recognition and that there is a very general call for traffic measuring apparatus.

NO ENGINEERING OBSTACLE

The automatic telephone system can furnish any kind of measured service which is desirable. There is no engineering obstacle; the use of flat rates or of measured service is entirely a matter of business policy.

Measured service at once divides itself into two classes, credit service and cash service. Credit service requires that the amount of service sold shall be recorded. Cash service imposes the more difficult task of collecting money for the service before the service is rendered. Thus the two requirements vitally affect the design of apparatus.

Individual lines may have the measuring apparatus at the central office or the substation. Party lines require that this apparatus be located at the substation.

THE CONDITIONS TO BE MET

The following combinations of conditions have been met by devices for connection with automatic exchanges.

For credit service we have:

1. Meter at central office, records completed calls.
2. Meter at substation, operated by push-button to record completed calls.
3. Meter at substation, self-acting to record completed calls.
4. Meter at substation, records time line is used (cumulative time meter).

For cash service we have:

5. Coin box, coin deposited when called station, answers, collected at once.
6. Coin box, coin deposited before dialing, collected when called station answers.
7. Coin box, automatic and manual, local calls free, toll calls cash (audible signal to operator).
8. Coin box, automatic and manual, coin deposited before dialing, collected or returned on release of connection, toll calls cash (audible signal to operator).

1. Meter in central office, records completed calls.

The recording device used in this case (Fig. 1) consists of a train of four recording wheels, driven by an electro-magnet through a ratchet. It is of a type which has been in use for many years. Details of mechanical construction are not necessary here.

DIRECT OR INDIRECT CONNECTION

Each meter is associated with the line whose calls it is to record. The connection is either direct, by the inclusion of a meter winding in the line circuit, or indirect, by means of a relay which is in the line circuit. The meters themselves may be located at the top of the line switchboard (Fig. 2) or on a separate rack. In either case, it can be arranged so that the meters are locked from ordinary workmen and accessible only to authorized persons.

When the meter is connected directly to the line, it has two windings. A low resistance winding is placed in series with the negative side of the circuit. A high resistance, polarizing winding is controlled by a local circuit. The relation of the windings is such that neither winding along can pull up the registering armature. It requires that the windings assist

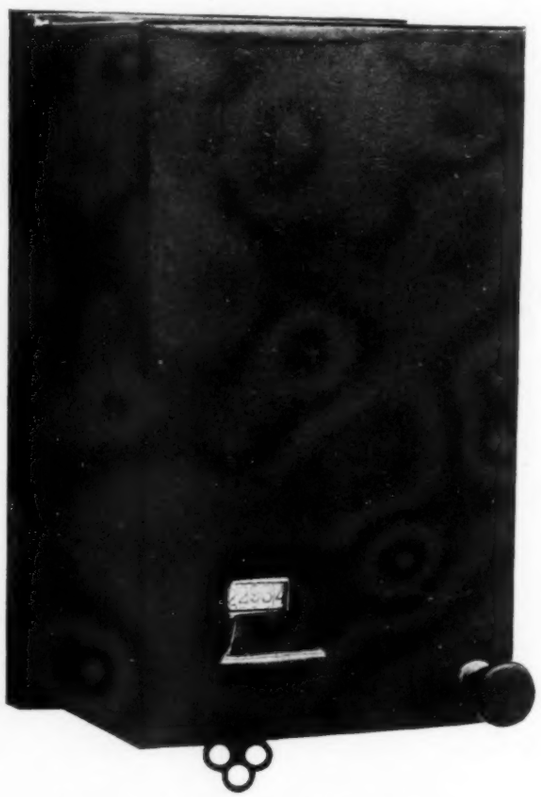


Figure 4. Push-button Sub-station Service Meter.

each other to cause registry. But when the armature is once pulled up, the polarizing winding will hold it up, even if the current in the low resistance winding be reduced to zero.

The meter is located in the part of the line circuit devoted to originating calls (Fig. 3). All calls orig-

inated on the line must pass through it. All calls going to the line escape the meter.

The initiation of a call causes the polarizing winding of the meter to be energized. The line current flows through the low resistance or series winding, but opposes the polarizing winding.

When the called station answers, the connector switch reverses the polarity of the current fed to the calling station. This causes the series winding of the meter to assist the polarizing winding. The meter armature pulls up, registers one call and short circuits the series winding. The polarizing winding holds the armature up until the call is released, at which time its current is cut off.

If the called subscriber hangs up his receiver and takes it down again, the resulting reversals of battery polarity will not affect the meter, because the series winding is cut out.

If the called station does not answer, the meter will not register because the line current is not reversed.

If the subscriber calls a telephone to which service is free, no record is made. Fire, police, information, etc., come in this class. This is accomplished by putting free telephones in a group by themselves on

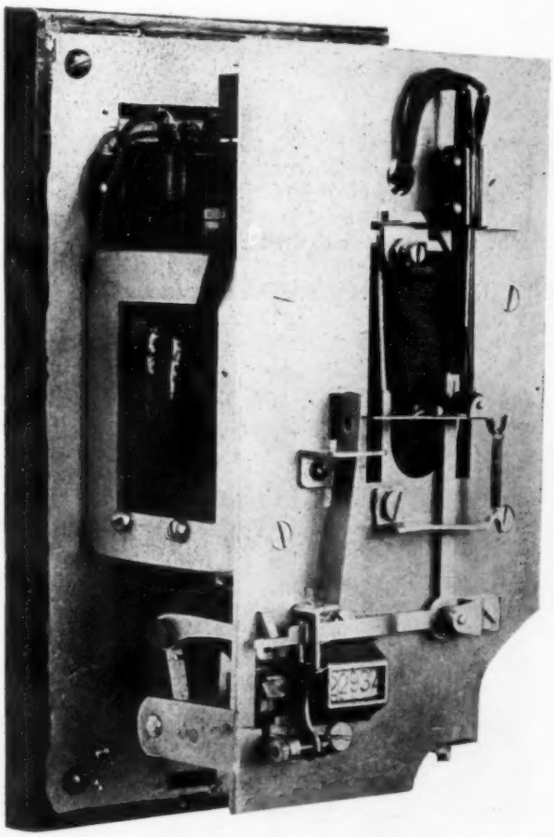


Figure 5. Push-button Sub-station Service Meter. Cover Removed.

a board whose connectors do not reverse the battery supply.

TRANSMISSION LOSS LOW

Conversation on free calls must be held through the series winding of the meter. Such calls are usually between nearby points, so that transmission is not much of a factor. But in addition the series coil is of low resistance (22 ohms), and there is a copper sleeve over the core, so that the transmission loss is very low.

If it is desired to place the meters at a distance from the lineswitch boards, grouping them all at one place, a relay takes the place of the meter, but is placed in the trunk circuit. This relay merely closes

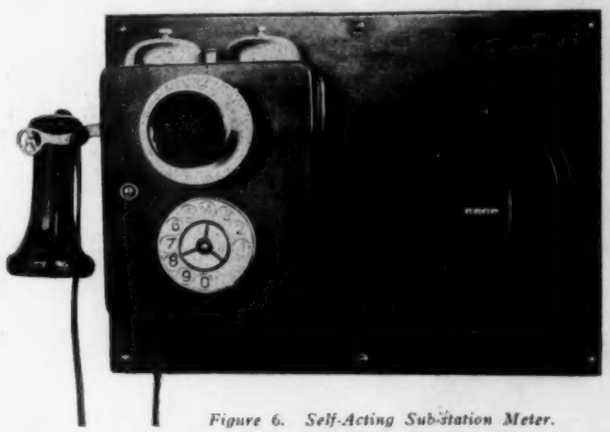


Figure 6. Self-Acting Sub-station Meter.

a single wire circuit leading through the lineswitch bank to the meter itself, which now has only one winding. Thus it requires but one wire per meter from the lineswitch boards to the meter board.

2. Credit meter at substation, operated by push-button:

This type of meter is essentially a counting device, operated by a push-button, with means for requiring the subscriber to register when the called station answers, and safeguards against registering more than once for such a call.

The meter (Fig. 4), has a train of counting wheels whose numerals appear at a rectangular window. A push-button at the lower right hand corner of the box is the subscriber's means of control.

Inside the meter (Fig. 5), there is the counting mechanism (5 numeral wheels), a group of electrical contact springs, and a polarized electromagnet whose winding is shunted by a condenser.

METHOD OF OPERATION

In normal operation, the subscriber dials the desired number in the usual way. When the called station answers, the connector switch reverses the current fed to the calling line. This energizes the polarized electromagnet in the meter and causes it to close the three contact springs. By them a dead short circuit is placed on the transmitter and a low resistance (30 ohms), shunted around the receiver.

The calling subscriber can hear the called party as he answers, but cannot speak to him. Pressing the button he moves the counting wheel and frees the three springs. Conversation may now proceed.

If the push-button be pressed when the telephone is not in use, no record is made, because normally the pawl which works the recorder is out of place and cannot engage the wheel. It requires the movement of the polarized electromagnet to bring the pawl into line with the wheel, so that the pressing of the button can rotate the number wheel.

When a call has once been recorded, the pawl is again thrown out of line so that further actuation of the button will have no effect.

All conversations are held through the electromagnet and the condenser. The magnet is wound to sixteen ohms and the condenser has two microfarads capacitance.

Free calls are handled as described for the central office meter.

This meter requires four wires between itself and the telephone set.

3. Meter at substation, self acting:

The self-acting meter (Fig. 6), appears like a cylinder with a window at which appear the numbers on

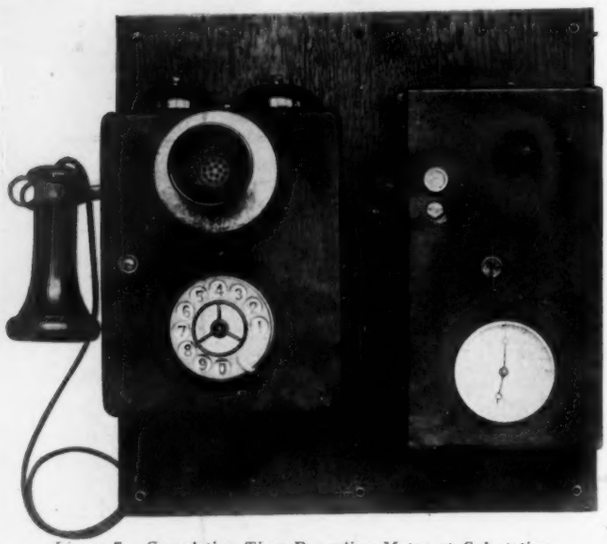


Figure 7. Cumulation Time Recording Meter at Sub-station.

the register wheels. It requires four wires to connect it to the telephone set.

GUARDING AGAINST FRAUD

The subscriber dials the call as usual. When the called station answers, the reversal of battery current actuates the meter so that the pawl is in a position to move the number wheel when release shall occur. The electromagnet is short circuited during conversation. When release occurs, the apparatus restores itself to normal. In so doing, the pawl turns the number wheel so as to record the call.

In its normal condition, the electromagnet is short circuited. When receiving a call, the coil is therefore not in circuit. If, however, the dial should be turned while the receiver is off the hook, the electromagnet will come into the line in series with the talking apparatus.

On free calls, the electromagnet is in series with the line and conversion must be held through it. Its resistance is 40 ohms, and it is shunted by a half microfarad condenser.

Since free calls are never set up over very long distances, the transmission loss is not much of a factor. On all calls where transmission counts, the coil is short circuited and, therefore, does not affect speech.

The user might attempt to avoid registry by momentarily depressing the hook before the called station answers. He would expect by the momentary opening of the line to cause the meter operating magnet to restore the pawl to normal before it had caught the next tooth on the number wheel. This would be successful if it were not for a slow-acting element, which requires that the line be held open long enough to cause release of the switches. The dishonest person soon learns that he obtains nothing by this procedure.

4. Cumulative time meter at substation:

The cumulative time meter is essentially a clock controlled by an electromagnet so as to run only while a completed call is held. In appearance it is a rectangular box, with a clock face appearing near the lower end. (Fig. 7.)

TWO METHODS OF CHARGING

This device has two varieties. The first variety counts time only, the second variety makes an arbitrary charge of one minute at the beginning of each call. The latter is to enable the operating company to collect part of its return in proportion to completed calls, and the rest in proportion to time of occupation of apparatus.

When the subscriber takes the receiver from the hook to make a call, it is necessary to turn a knob on the meter box. This takes a short circuit off the calling device. He now dials the call. When the called station answers, the reversal of current actuates a polarized electromagnet which starts the clock and short circuits the relay.

If a fixed charge of one minute is made, the electromagnet advances the clock hands one minute at the time of starting.

The clock will run until the calling subscriber hangs up his receiver. Anything that the called party may do will not affect the clock, because the polarized electromagnet is shunted out.

When the calling subscriber hangs up his receiver, the mechanism restores itself to normal, stopping the clock.

FIRE CALLS DO NOT AFFECT METER

Received calls do not disturb the meter and there is no added apparatus through which conversation must be held.

Free calls do not affect the clock, and must be conducted through the electromagnet and its shunt.

5. Coin box, nickel last, collected at once:

In appearance this is a rectangular box with a coin slot at the upper right hand corner (Fig. 8).

Essentially it consists (Fig. 9), of a coin chute and cash box, a polarized electromagnet, a group of springs, and a trip link to be actuated by the coin.

When the subscriber dials the number, the coin

Figure 8.

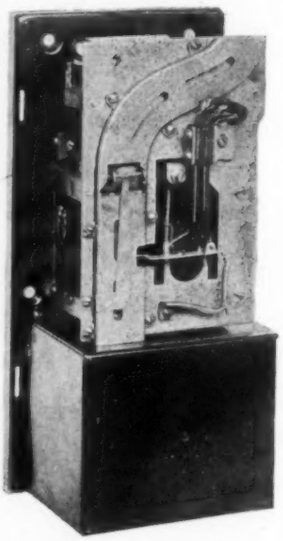


Figure 9.

Nickel Last Coin Box, Exterior and Interior

box is not affected. But when the called station answers, the reversal of current energizes the electromagnet, moving the trip link to the left. It also closes three springs which render the talking apparatus practically inoperative, as described above. The user can, however, hear the voice of the called party.

Upon perceiving that the called station has answered, the calling party drops the coin into the coin slot. On its way through the coin chute, the coin presses the left end of the trip link down, unlatching the link from the magnet lever and restoring the talking apparatus to full effectiveness.

COIN BOX, NICKEL LAST

When the connection is released, the electromagnet is restored to normal, and the magnet lever once more engages the trip link, ready for the next call.

If the called station does not answer, or if the call is to a free line, the current does not reserve and no coin is required.

Under all conditions the electromagnet is left in series with the talking apparatus. Its resistance is 25 ohms, and it is shunted by a two-microfarad condenser.

The transmission loss due to the presence of the electromagnet and condenser is about 0.3 mile.

6. Coin box, coin deposited before dialing, collected when called station answers:

It has been found that sometimes the calling party is a little slow in depositing the coin when the called station answers. This might result in the latter hanging up and causing the calling party to call again. Of course, people ought to have the nickel ready and ought to drop it in the slot promptly. But sometimes they are slow.

To obviate this apparent difficulty, the coin box (Fig. 8), has been arranged to induce the user to deposit a nickel before dialing, so that it will be ready for instant collection. The coin is held there in plain view, where it can be removed by the subscriber if the called station fails to answer, or if the called line is one to which service is free.

The operation is as follows: The user first places a nickel in the coin slot, where it rests. He then dials the number. When the called station answers, the coin box removes the support for the coin, whereupon it drops into the chute, trips the springs, and passes into the cash compartment.

If the coin is not collected, the user recovers it by hand.

Calls can be made without the preliminary deposit of a coin, in which case the payment must be made when the called station answers.

7. Coin box, automatic and manual, local calls, free, toll calls cash:

LOCAL CALLS NOT AFFECTED

This service requires no electrical connection between the telephone and coin box. Any desired box is mounted so that its audible signals (bell or gong) will affect the transmitter. More than one type has been used in this way.

Local calls are dialed as if there were no coin box.

To call long distance, the user dials "O" or such other number as is indicated by the directory. The operator may put the call through while the subscriber waits, or may ask for his number and call him when the line is ready. In either case, the operator requests that the coin be deposited, and verifies the correctness of payment by the audible signals.

8. Coin box, automatic and manual, local calls nickel first, collected on release; toll calls cash as usual:

This coin-telephone (Fig. 10), is built as one unit. Three slots are provided, so as to handle nickels, dimes, and quarters. The deposit of any coin gives a distinctive bell or gong signal and in addition prepares the line for dialing. No coin is necessary to receive a call.

To use the telephone to make a call, a coin is first deposited in the appropriate slot. The number is then dialed as usual. When the called subscriber answers, conversation takes place.

When the calling subscriber hangs up to release,

Figure 10. Gray Coin Box Telephone.

the machine drops the coin into the cash compartment.

If the call is unanswered, or is to a telephone for which calls are free, the release action of the subscriber causes the coin to be droped into the return pocket, where he can get it again.

Long distance calls pass through the hands of an operator, who calls for the deposit of the required fee in the usual manner.

Fire System in Delphos, Ohio

A new system for use in case of fire has been installed by the Delphos, Ohio, Home Telephone Company and all residents of the city are asked to familiarize themselves with the method of placing calls in case of a fire so as to get the best service.

Special lines have been run from the telephone exchange to the city building, water works station and to the electric light plant. All three of these lines are operated with one plug and, if a call is correctly made by the party reporting the fire, all three places will get the call at the same time.

Side Tone in a Repeating Circuit

A Sequel to the Series "Loading Coils versus Repeaters" Which Last Appeared in June

IN the various articles which have appeared in TELEPHONE ENGINEER on the subject of loading evils, no reference has been made to those essential features of a repeating circuit that may involve that disturbing factor known as side-tone.

The writer has not discussed this feature in connection with the discourse on repeaters, because the technical features of the repeater and repeater circuits are sufficiently intricate in themselves to require long study and application for their thorough understanding.

It has been found impossible up to date to eliminate side-tone in an ordinary substation without possible sacrifice of efficiency from the transmission standpoint. It is a well-known fact that considerable increase in transmission efficiency of the ordinary substation may be obtained provided a specified amount of side-tone may be permitted. In other words, it has always been possible to increase transmission efficiency at a sacrifice of receiving efficiency—or to increase receiving efficiency at a sacrifice of transmission efficiency. Briefly stated, this difficult situation may be said to be based on the law of compensation; and it has been universally agreed, as far as the writer is aware, that certain sacrifices must be made. In this connection it may be said that it has been found, in the use of loading coils, that a loading coil is that agent which makes up for a large number of sacrifices in transmission such as has been referred to in side-tone.

This question of side-tone is of particular interest in connection with loading coils, as it is found that a repeater station, due to the method which is followed in wiring it into a circuit and to its high degree of sensitivity, is decidedly subject to side-tone. It is thought that the electrical theory involved in the elimination of side-tone may be more clearly understood provided it is shown in connection with the electric circuits of a substation.

Side-tone in a substation may be eliminated by providing it with a transmitter, a receiver, an auxiliary resistance and a transformer having a plurality of windings which, in combination with a telephone line, shall satisfy the following requirements: Two identical substations designed for two-way communications and connected by a line of a given impedance and length, the amount of energy absorbed by the receiver at the receiving station shall be the maximum part of the total telephonic energy developed by the transmitter at the transmitting station consistent with invariable two-way communication, and with only a reasonable amount of discrimination against disturbing line noises. This fundamental requirement may be stated as follows: The transmitter and the receiver should be conjugate, that is, the side-tone in the receiver, brought out by the actuation of the transmitter by sound waves, shall be negligible; the line and the auxiliary resistance shall be conjugate in order that none of the energy absorbed by the substation be wasted in said auxiliary resistance; for a given line having a predetermined impedance the telephonic energy, developed by the transmitter, shall be maximum; the amount of energy delivered by the line to the substation shall be maximum. In other words, the impedance of the substation, as seen from the lines, shall be equal to the impedance of the line itself; at a very minute sacrifice of efficiency it shall be possible to discriminate effectively against line disturbances as contrasted to the telephonic signals from the communicating stations.

A substation of such design is very satisfactory in that its efficiency from the transmitter of one station to the receiver of the communicating station, which cannot be exceeded by any other substation, is maximum whether satisfying the requirement of receiver and transmitter conjugacy or not. It is also efficient in that a minimum number of elements is employed, since it is absolutely necessary that an auxiliary element is used to secure freedom from side-tone.

The question at this point may arise in the reader's mind as to whether the addition of any element such as an auxiliary resistance, which is—as before stated—necessary to secure freedom from side-tone, would not at the same time reduce the efficiency of the substation. This is not the case, however, since energy is unavoidably wasted in any resistance, no matter what its efficiency may be—simply as a matter of heat.

It may be of interest to note that Dr. George A. Campbell claims for one of his numerous substation inventions that a substation which he has designed has a theoretical maximum efficiency which cannot be exceeded by any substation that does or does not contain side-tone.

In considering here the claims of Dr. Campbell's invention, it may be assumed that the most simple form of such a substation is that in which the receiver and transmitter are connected in series with each other across the line. In such an arrangement it will be evident that the over-all efficiency is a maximum when the resistance of the receiver is equal to that of the transmitter, in other words, when 50 per cent of the energy delivered by the line to the substation is wasted in the transmitter and 50 per cent of the energy delivered by the transmitter is wasted in the receiver. In such an arrangement the disadvantage of full side-tone is obtained. In the substation invented by Dr. Campbell it is claimed that 50 per cent of the energy delivered by the line to the substation is wasted in the transmitter, but not in the auxiliary resistance—such auxiliary resistance and the line being conjugate; that the efficiency is as great as that of the simple series substation. When transmitting from such a station no energy is wasted in the receiver, but 50 per cent of the energy received by the transmitter is wasted in the auxiliary resistance. In this manner transmission efficiency is at a maximum, neither transmitting nor receiving efficiency being reduced by the addition of resistance, which is necessary to secure freedom from side-tone.

While the writer agrees with the contention of Dr. Campbell in this respect, it will be evident that the design of the auxiliary resistance to be used must include a winding of resistance of practically no temperature coefficient and a transformer that must be safeguarded against self-magnetization. Since Dr. Campbell does not describe such a resistance or transformer in detail, it will be necessary in considering his theory to bear in

mind both of these points in connection with the design of such a resistance, or transformer.

As a matter of clearness in considering Dr. Campbell's contentions, Figures 1, 2, 3, 4, 5 and 6 are schematic diagrams of six forms of substations. Figures 7, 8, 9, 10, 11 and 12 are diagrams indicating the relative direction of the current flow in the several circuits, the dotted line indicating elements through which no current flows.

In order to illustrate the principles involved in Dr. Campbell's invention, a general theoretical discussion will

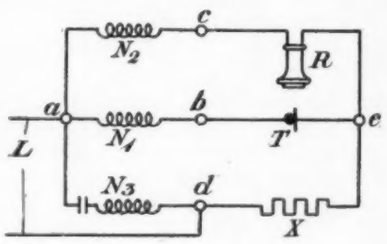


Fig. 1.

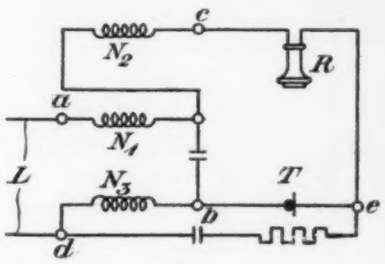


Fig. 2.

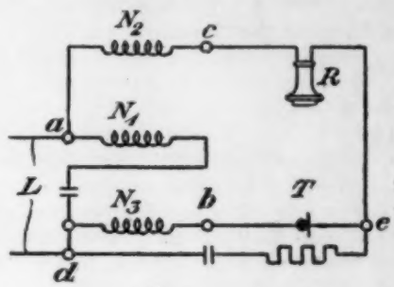


Fig. 3.

now be given which applies to all substations that satisfy all requirements as stated. In the formulae which are to follow, the subscripts $_1$, $_2$, $_3$, $_4$ will refer to transmitter, receiver, auxiliary resistance and line, respectively. Thus 1_1, 1_2, 1_3, 1_4 will denote the current flowing in the transmitter, receiver, auxiliary resistance and line, respectively, while R_1 will denote the resistance of the transmitter; R_2, resistance of the receiver, etc.

Consider a substation, therefore, consisting of transmitter, receiver, auxiliary resistance and appropriate transformer windings connected to a line of given impedance. It is a well-known principle that if the terminal impedance is connected to a source of electromotive force through a line of impedance

$$Z = R_4 + iR'_4$$

where R_4 is the resistance and R'_4 is a reactance component of the impedance, the terminal impedance must be R_4 minus R'_4 for the maximum absorption of energy. The condition in order that the substation shall have the maximum absorption from the line is that its impedance, as seen from the line, shall be equal to the line impedance.

Figure 1 will explain this reference as follows: Suppose a substation be disconnected from the line and the impedance from the station be measured across the terminals *a* and *d*, then the impedance so measured shall be equal to the impedance of the line. It will be evident that in a line so terminated at either end by a substation satisfying this requirement, the line may be replaced, as far as transmitting from either substation is concerned, by an impedance element of resistance equal to the impedance of the line.

Any reactance effect, which is always in practice very small, would be eliminated by neutral reactions, which need not be considered. The condition that the substation have a maximum energy absorption from the line is met by having the impedance, as seen from the line, be a pure resistance of such a volume as to equal the impedance of the line. This condition may be more clearly stated as follows: Let an electromotive force be impressed on the substation terminals through a resistance equal to the impedance of the line, then the energy consumed in the substation shall be equal to the energy consumption in the said resistance. It will also be seen that the line and auxiliary resistance are in conjugate because the auxiliary resistance is connected to points of equal potential with respect to any electromotive force that is applied to the terminals. It will also be clear that the impedance of the substations, as seen from the line, shall be equal to that of the line. Upon this basis E_4 as an electromotive force is impressed through R_4 on a substation whose transmitter and receiver resistances are R_1 and R_2, respectively, and the resultant currents in line transmitter and receiver be I_4, I_1, and I_2, respectively. The impedance across the terminals of such a station being R_4, as seen from the line, and the total resistance in series with E_4 is $2R_4$, and since the current in the line is I_4, it follows that

$$\frac{E_4}{2R_4} = I_4$$

the total energy consumed may then be expressed by the formula:

$$I_4^2 R_4 + I_1^2 R_1 + I_2^2 R_2 = I_4 E_4 = \frac{E_4^2}{2R_4}$$

Since the energy consumed by the substation is equal to the resistance of R_4, it follows that requirement 4—as stated above—may be formulated by the following:

$$R_4 (I_4)^2 = (I_2)^2 R_2 + (I_1)^2 R_1 = \frac{(E_4)^2}{4R_4} \quad (1)$$

The above states that the energy consumption in the resistance R_4 is equal to that in the substation, and that the substation is equivalent, as seen from the line, to a resistance of value R_4.

Similarly, if the transmitter and receiver are conjugate, the condition that the transmitter shall have its maximum output to line and auxiliary resistance may be stated in formula form as follows: Let an electromotive force E_1 in the transmitter produce currents I_1, I_4 and I_3 in transmitter, line and auxiliary resistance. For maximum output then, it may be said that

$$(I_1)^2 R_1 = (I_4)^2 R_4 + (I_3)^2 R_3 = \frac{(E_1)^2}{4R_1} \quad (2)$$

This equation conforms with equation (1) and may be interpreted as follows. Let the transmitter be disconnected from the terminals *b* and *c* and let the impedance be measured across said terminals. Then if equation (2) is satisfied, the impedance so measured is equal to the impedance of the transmitter In other words, the impedance of the combination as seen from the transmitter is equal to that of the transmitter itself.

In completing this general discussion it remains to consider the energy division between receiver and transmitter when receiving, and between line and auxiliary resistance when transmitting. Let W_0 be the total amount of telephonic energy developed by the transmitter at the transmitting substation; then, by equation (2), $\frac{1}{2}W_0$ is the amount of energy delivered to line and auxiliary

resistance. Letting the amount of energy taken by the auxiliary resistance be X times that taken by the line, then the amount of energy taken by the line is

$$\frac{\frac{1}{2}W_0 \quad 1}{(1+X)}$$

so that the transmitting efficiency is measured by

$$\frac{1}{(1+X)} \quad (3)$$

Of the total energy delivered to the receiving substation, let the transmitter absorb Y times that absorbed by receiver; then the receiving efficiency is measured by

$$\frac{1}{(1+Y)} \quad (4)$$

The over-all efficiency from transmitter of one station to receiver of communicating station is clearly proportional to the product of the transmission efficiency and receiving efficiency; therefore the over-all efficiency is according to formulae (3) and (4):

$$\left(\frac{1}{1+X}\right)\left(\frac{1}{1+Y}\right)$$

If X and Y are independent, clearly the overall efficiency would be a maximum for $X=Y=O$. It may be readily shown, however, that X and Y are connected by the relation $XY=1$. Eliminating X—by means of this relation—the expression for the over-all efficiency becomes

$$\frac{Y}{(1+Y)^2} \quad (5)$$

In order to demonstrate the statement that $XY=1$, designate the elements T, R, X and L by *1*, *2*, *3* and *4*, respectively, and let *1* and *2* be conjugate and also *3* and *4* be conjugate. Further it will be assumed for an electromotive force in branch *4*, equation (1) is satisfied while for an electromotive force in branch (1), equation (2) is satisfied. Let S_{11} denote the current produced in branch or element *1* by a unit electromotive force in branch *1*, S_{12} the current produced in branch *2* by a unit electromotive force in branch *1*, etc. Then by the conjugacy of branches *1* and *2* and branches *3* and *4*, it follows:

$S_{12}=S_{34}=O$

Also by equation (1)

$$(S_{44})^2R_4=(S_{42})^2R_2+(S_{41})^2R_1=\frac{1}{4R_4} \quad (1^1)$$

and by equation (2)

$$(S_{11})^2R_1=(S_{13})^2R_2+(S_{14})^2R_4=4R_1- \quad (2^1)$$

From a fundamental principle in elementary algebra, we deduce that $S_{41}=S_{14}$. That is, the current set up in branch *4* by a unit electromotive force in branch *4* is equal to the current set up in branch *4* by a unit electromotive force in branch *1*. Multiplying equation (1^1) by R_4 and equation (2^1) by R_1 and subtracting, it follows that:

$(S_{42})^2R_2R_4=(S_{13})^2R_1R_3$(a).

The energy consumed in branch *3* is X times that consumed in branch *4* when an electromotive force acts in branch *1*; therefore:

$(S_{13})^2R_3=X(S_{14})^2R_4$(b).

Also the energy consumed in branch *1* is Y times that consumed in branch *2* when an electromotive force acts in branch *4*; whence

$(S_{14})^2R_1=Y\ (S_{24})^2R_2$(c).

Multiplying (*b*) and (*c*)

$(S_{13})R_1R_3=xy\ (S_{24})^2R_2R_4$(d).

From (a) and (d) it follows at once that $XY=1$.

Obviously the expression given by formula (5) is a maximum when $Y=1$. This means that for a given amount of energy developed in the transmitter at the transmitting substation a maximum amount is delivered to the receiver at the receiving substation connected by the line, when $Y=1$. Since the maximum amount of energy in the receiver is the principal thing desired in telephony, it would appear that the substation should be designed to make $Y=1$. Another consideration, however, would modify this, namely, the effect of line noise. Since the line noise originates in the line the amount delivered to the receiver is proportional to

$$\frac{1}{1+Y}$$

while the amount of energy delivered from the transmitter of the communicating station is proportional to

$$\frac{Y}{(1+Y)^2}$$

The ratio of the latter to the former is

$$\frac{Y}{1+Y^2}$$

and this increases as Y increases beyond unity. It stands to reason, then, that if Y is made greater than unity the substation discriminates against line noise as compared with the signals it is desired to receive. The amount of discrimination desired depends of course on the amount of line noise present.

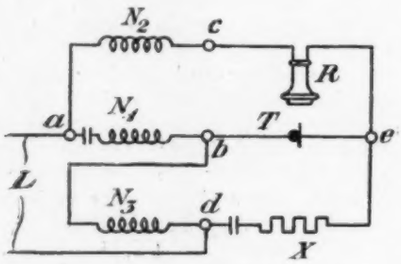


Fig. 4.

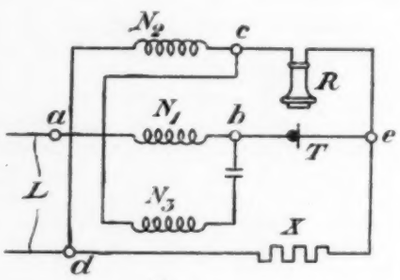


Fig. 5

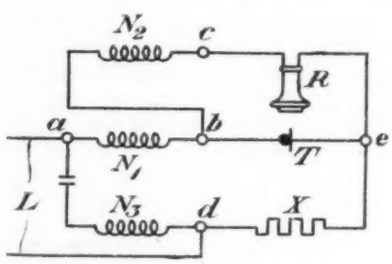


Fig. 6

Proceeding now to a description of the specific circuits, in Fig. 1 a substation is illustrated comprising a transmitter T, a receiver R, an auxiliary resistance X, a line L and a three winding transformer having windings N_1, N_2 and N_3. The receiver R is connected in series with the winding N_2 between terminals a and e. In a similar manner the transmitter T is connected in series with the winding N between said terminals. The auxiliary resistance X is connected in series with the winding N_3 between terminals a and e and the line L is connected

one side to the terminal a and the other side to the junction point d between the auxiliary resistance X and the winding N_3. If desired a condenser may be inserted in series with the winding N_3 to prevent the flow of direct current through said winding. Direct current from a central energy source is supplied to the line L and flows in parallel through the transmitter and receiver and from there through the auxiliary resistance X.

The operation of the substation of Fig. 2 is transmitting will be clear from an inspection of Fig. 7 in which the arrows indicate the relative directions of current flow. The actuation of the transmitter varies the current flowing in the transmitter circuit, its action being equivalent to setting up in the transmitter a variable electromotive force which causes an alternating current to flow. The direction of this current at a given instant of time is indicated by the arrow designated I_1. Since the transmitter and receiver are conjugate during transmission, no current will flow through the receiver and the auxiliary resistance X is in a series circuit with the transmitter. Consequently the current I_3 flowing through the auxiliary resistance is equal to the current I_1 flowing through the transmitter. At the terminal a the current I divides and a current I_4 flows over the line and back to the junction point d, while a current I_3-I_4 flows through the windings N_3 to the point d. Potentials are induced in the windings of such value and direction as to reduce the terminal c to the same potential as the terminal e, so that no current flows through the receiver during transmission.

The action when receiving is indicated as follows: A potential applied to the line causes a current I_4 to flow to terminal a, through the winding N_3 to the terminal d and back to the line. Since the line and the auxiliary resistance X when receiving are conjugate, no current flows through the auxiliary resistance. The current flowing through the winding N_3 sets up electromotive forces in the windings N_2 and N_1, whereby a current I_1 equal to I_2 flows in a local circuit from terminal a, through the winding N_1, transmitter T, receiver R and winding N_2 back to terminal a. The electromotive forces reduce the terminal e to the same potential as the terminal d, so that no current flows through the auxiliary resistance. As a result of this no energy loss occurs in the auxiliary resistance and while the received current flows through the transmitter and receiver in series, the energy thus wasted is no greater than the transmitter loss in a standard substation.

The proportioning of the arrangement of Fig 1 to satisfy the fundamental requirement of the substation is as follows: We will ignore resistances of the transformer windings and the leakage between the transformer windings; also the fact that the self impedances are very large compared with the impedances of the component elements of the substation or the impedance of the line.

To formulate the condition for conjugacy of transmitter T and receiver R, assume an electromotive force in the transmitter circuit and assume that the desired condition of conjugacy is satisfied. In other words, assume that the terminals of the receiver are at points of equal potential with respect to an electromotive force applied to the transmitter. Let I_1, I_2, I_3, and I_4 denote the currents flowing in the transmitter, receiver, auxiliary resistance and line, respectively, and R_1, R_2, R_3, and R_4 denote the resistances of the corresponding elements. Also, let the number of turns of the transformer windings connecting terminals a and b, a and c and a and d, respectively, be represented as follows:

$$N_{ab}=n_1$$
$$N_{ac}=n_2$$
$$N_{ad}=n_3$$

The condition of conjugacy of the receiver with respect to the transmitter requires that no current flow through the receiver and hence $I_2=O$. It is also clear from Fig. 7 that if no current flows through the receiver, $I_3=I_1$. Assuming a potential V_{ae} applied across the terminals a and e, since the potential so applied must equal the sum of the potential drop through the winding N_3 and the IR drop through the auxiliary resistance X, we have:

$$V_{ae}=R_3I_1+Kn_3$$

where K designates the potential drop per turn of the transformer windings.

Since terminals c and e are at the same potential, it follows that

$$V_{ae}=Kn_2$$

Combininng the above, we have

$$R_3I_3+Kn_3=Kn_2$$

Assuming a potential V_{ad} applied across the terminals a and d, both the potential drop through the line and the IR drop through the winding N_3 must equal the potential so applied and we have

$$V_{ad}=Kn_3=R_4I_4$$

Solving the above equations we have

$$R_3I_3=K\,(n_2-n_3)$$
$$R_4I_4=Kn_3$$

whence

$$\frac{R_3I_3}{R_4I_4}=\frac{n_2-n_3}{n_3}$$

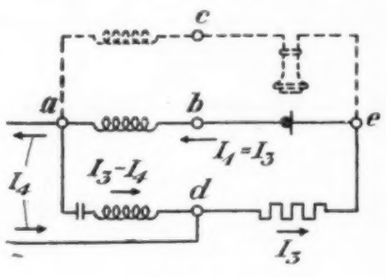


Fig. 7

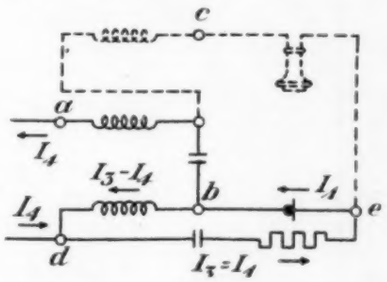


Fig. 8

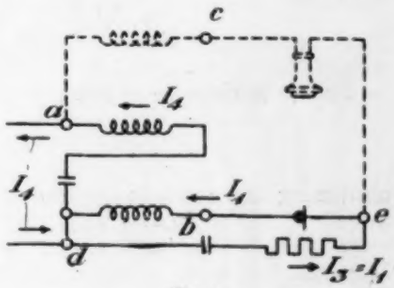


Fig. 9.

Furthermore, since the sum of the ampere turns of the three windings of the transformer must equal zero:

$$n_1I_3=n_3\,(I_3-I_4)$$

$$\frac{I_3}{I_4}=\frac{n_3}{n_3-n_1}$$

Combining the above equations, we get

$$\frac{I_2}{I_4}=\frac{n_3}{n_2-n_1} \quad (7)$$

and

$$\frac{R_3}{R_4} = \frac{(n_2-n_3)_2\ (n_3-n_1)}{n_3} \quad (8)$$

When receiving the line and auxiliary resistance are conjugate so that no current flows through the auxiliary resistance and the transmitter and receiver are in a local series circuit. Assuming a potential drop between terminals c and b it is apparent that the sum of the drop through the winding N_2 and the drop through the winding N_1 will equal the IR drop through the receiver and transmitter, consequently

$$K\ (n_2-n_1)=(R_1+R_2)\ I_1$$

Also since points d and e are at the same potential, it follows that the sum of the drops through the transmitter and windings N_1 and N_3 is zero. Hence

$$Kn_3-KN_1-R_1I_1=O$$

or

$$Kn_3=Kn_1-R_1I_1$$

Combining we get

$$\frac{R_1+R_2}{R_1} = \frac{n_2-n_1}{n_3-n_1} \text{ or } \frac{R_2-n_2-n_3}{R_1\quad n_3-n_1} \quad (9)$$

Also since the resultant ampere turns of the transformer windings equal zero

$$n_3I_4=(n_2-n_1)\ I_1$$

from which we get

$$\frac{I_1}{I_4} = \frac{n_3}{n_2-n_1} \quad (10)$$

Now referring to equation (2) previously derived, and remembering that transmission $I_1=I_3$, said equation may be written

$$R_1=\frac{I_4^2}{I_3^2}R_4+R_3$$

From the equation (7) it is apparent that

$$\frac{I_4}{I_3} = \frac{n_3-n_1}{n_3}$$

substituting this value in equation (2) we have

$$R_1=\left(\frac{n_3-n_1}{n_3}\right)R_4+R_3 \quad (11)$$

During reception it will be apparent from Fig. 4 that $I_1=I_2$. Substituting this value in equation (6), we get

$$R_1=yR_2 \quad (12)$$

Collecting formulæ (8), (9), (11) and (12), we have the following:

$$\frac{R_3}{R_4} = \frac{(n_2-n_3)\ (n_3-n_1)}{n_3^2}$$

$$\frac{R_2}{R_1} = \frac{n_2-n_3}{n_3-n_1} \quad (13)$$

$$R=\left(\frac{n_3-n_1}{n_3}\right)^2R_4+R_3$$

$$R_1=yR_2$$

Formulæ (13) may be written more generally as follows:

$$\frac{R_3}{R_4} = \frac{(n_{ac}-n_{ad})\ (n_{ad}-n_{ab})}{n_{ad}^2}$$

$$\frac{R_2}{R_1} = \frac{n_{ac}-n_{ad}}{n_{ad}-n_{ab}} \quad (A)$$

$$R_1=\left(\frac{n_{ad}-n_{ab}}{n_{ad}}\right)R_4+R_3$$

$$R_1=yR_2$$

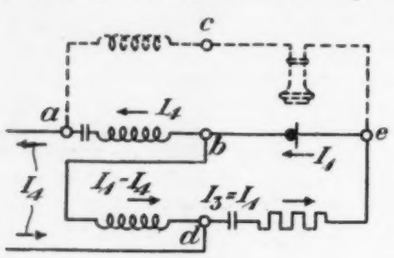


Fig. 10

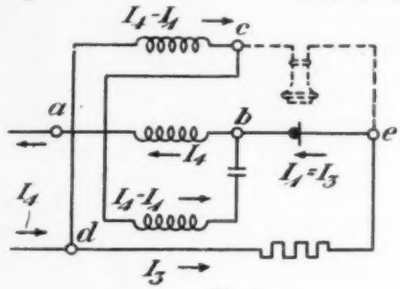


Fig. 11.

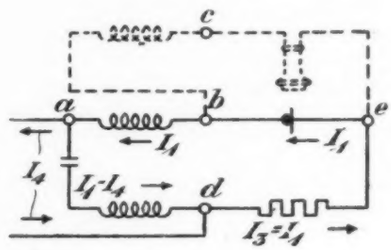


Fig. 12.

The group of equations designated "A" constitute the general design formulæ for this type of substation and, properly interpreted, determine the proper proportions of the elements of each substation herein disclosed.

For the substation of Fig. 1, if we designate the winding radios

$$\frac{n_1}{n_3} \text{ and } \frac{n_2}{n_3}$$

by r and r', respectively, formulæ (13) (or A) become

$$\frac{R_3}{R_4} = (r'-1)\ (1-r)$$

$$\frac{R_2}{R_1} = \frac{r'-1}{1-r} \quad (14)$$

$$R_1=(1-r)^2R_4+R_3$$

$$R_1=yR_2$$

The third equation of the preceding group may be written

$$\frac{R_1}{R_4}=(1-r)^2+\frac{R_3}{R_4}$$

Combining this with the first equation of the group, we have

$$(1-r)^2+(r'-1)\ (1-r)=\frac{R_1}{R_4} \quad (15)$$

Combining the second and fourth equations of group (14), we have

$$r'-1=\frac{1}{y}(1-r) \quad (16)$$

Substituting this value in equation (15), we have

$$(1-r)^2+\frac{1}{y}(1-r)^2=\frac{R_1}{R_4}$$

which reduces to

$$(1-r)=\pm\sqrt{\frac{R_1}{R_4}\frac{y}{1+y}} \quad (17)$$

(C)

The plus and minus sign in equation (17) shows that there are two possible modes of winding the transformer corresponding to the two solutions.

From equations (16) and (17) we may derive the following:

$$(r'-1) = \pm \frac{1}{y}\sqrt{\frac{R_1}{R_4}\frac{y}{1+Y}} \qquad (18)$$

From equations (17), (18) and the first equation of group (14), we have

$$R_3 = \frac{1}{1+y} R_1$$

Consequently, the design formulæ of the substation of Fig. 1 may be expressed as follows:

$$R_2 = \frac{1}{y} R_1$$

$$R_3 = \frac{1}{1+y} R_1$$

$$1 - r = \pm \sqrt{\frac{R_1}{R_4}\frac{y}{1+y}} \qquad (B)$$

$$r^1 - 1 = \pm \frac{1}{y}\sqrt{\frac{R_1}{R_4}\frac{y}{1+y}}$$

The above formulæ determine the winding ratios and the resistances of the receiver and the auxiliary element in terms of the resistances of the line and the transmitter and the ratio Y. Since these three values are generally known, the remaining elements of the substation may be readily determined.

A modified form of substation is illustrated in Fig. 2. In this figure the receiver R and the winding N_3 are serially connected between the terminals b and e in parallel with the transmitter T. The line L is serially connected with the winding N, across the terminals b and d in parallel with the winding N_3. The auxiliary resistance X is connected across terminals d and e. Condensers may, if desired, be inserted as indicated to insure that the direct current supply will flow through the receiver R and the transmitter T and to prevent its flow through the auxiliary resistance X. In this form of substation the current supply from the central station flows over the line and through windings N_1 and N_2, receiver R, transmitter T and winding N_3 back to line.

The operation of the substation of Fig. 2 during transmission will be clear from Fig. 8. Since no current flows through the receiver, the auxiliary resistance and the transmitter are in a series circuit and the variable potential set up by the transmitter causes a current I_4 which is equal to I_3 to flow from the terminal d through the auxiliary resistance and the transmitter to the point b, where the current divides and a current I_4 flows through the winding N_1 and over the line L to point d, while a current $I_3 - I_4$ flows through the winding N_3 to the point d. Potentials are induced in the transformer windings whereby the terminal c is reduced to the same potential as terminal e, so that no current flows through the receiver during transmission.

The operation when receiving is illustrated in Fig. 14. An electromotive force applied to the line causes a current I_4 to flow from the line terminal a through the winding N_1, terminal b, winding N_3, terminal d and back to the line. An induced current is set up in a local series circuit including the transmitter and the receiver, so that a current I_1 equal to I_2 flows from terminal b through the winding N_2, through the receiver and the transmitter back to terminal b. Potentials are induced in the transformer windings whereby the terminal e is reduced to the same potential as terminal d, so that no current is

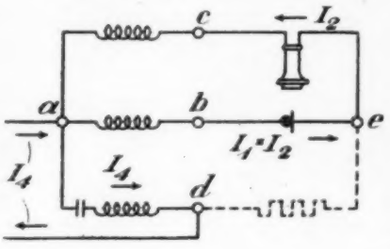


Fig. 13.

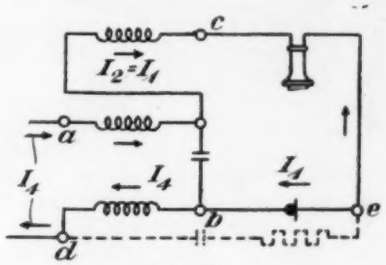


Fig. 14.

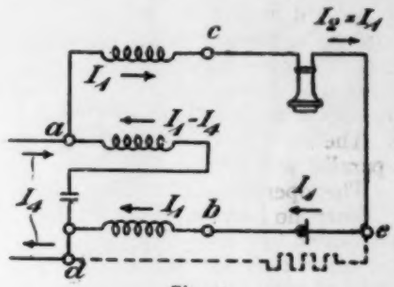


Fig. 15.

wasted through the auxiliary resistance X. The only received energy which is wasted is that lost through the impedance of the transmitter T, which is no greater loss than would occur in a standard substation circuit.

The design formulæ for the circuit of Fig. 2 may be readily determined from a consideration of formulæ (B). It will be observed in formulæ (B) that R_2 and R_3 are independent of the transformer connections, so that the first two formulas of said group hold for all the substations herein mentioned, since a comparison of Figs. 1, 2, 3, 4, 5 and 6 shows that the several substations differ from each other only in the transformer connections. Furthermore, if we write N_{ab} for n_1, N_{ac} for n_2 and N_{ad} for n_3, formulæ (B) becomes:

$$R_2 = \frac{1}{y} R_1$$

$$R_3 = \frac{1}{1+y} R_1$$

$$\frac{N_{ad} - N_{ab}}{N_{ad}} = \pm \sqrt{\frac{R_1}{R_4}\frac{y}{1+y}}$$

$$\frac{N_{ac} - N_{ad}}{N_{ad}} = \pm \frac{1}{y}\sqrt{\frac{R_1}{R_4}\frac{y}{1+y}}$$

Formulae (C) hold for all of the substations herein disclosed with a proper interpretation of the winding connections. A comparison of Figs. 1 and 2 shows that:

$$N_{ab} = n_1$$
$$N_{ac} = n_1 + n_2$$
$$N_{ad} = n_1 + n_3$$

Hence the last two of formulae (C) become

$$\frac{n_3}{n_1 + n_3} = \pm \sqrt{\frac{R_1}{R_4}\frac{y}{1+y}}$$

$$\frac{n_2 - n_3}{n_1 + n_3} = \pm \frac{1}{y}\sqrt{\frac{R_1}{R_4}\frac{y}{1+y}}$$

Writing $\frac{n_1}{n_2}$ as r and $\frac{n_2}{n_3}$ as r^1, the design formulae for Fig. 2 are

$$R_2 = \frac{1}{y} R^3$$

$$R_3 = \frac{1}{1+y} R_1$$

$$\frac{1}{r+1} = \pm \sqrt{\frac{R_1}{R_4}\frac{y}{1+y}}$$

$$\frac{r^1-1}{r+1} = \pm \frac{1}{y}\sqrt{\frac{R_1}{R_4}\frac{y}{1+y}}$$

A still further modification is illustrated in Fig. 3 in which the receiver R and the winding N_2 are connected in series across the terminals a and e, while the transmitter and winding N_3 are connected in series across terminals d and e in parallel with the auxiliary resistance X. The line L is connected across the terminals a and d in parallel with the winding N_1.

The operation is transmitting is illustrated in Fig. 4. Since no current flows through the receiver R the transmitter, auxiliary resistance and winding N_3 are in a local series circuit and the actuation of the transmitter sets up an electromotive force whereby a current I_1 equal to the current I_3 flows from terminal d through the auxiliary resistance X, transmitter T and winding N_3, back to terminal d. An induced current I_4 is thereby caused to flow from the terminal d through the winding N_1 and over the line L back to the terminal d. Electromotive forces are induced in the transformer windings of such value and the terminal c is reduced to the same potential as the terminal e and consequently no current flows through the receiver during transmission.

In receiving, as shown in Fig. 15, a current I_4 flows over the line from terminal d to terminal a. Since no current flows through the auxiliary resistance the transmitter and receiver are in a series circuit and a current I_1 equal to the receiver current I_2 flows from terminal a, through the winding N_2, receiver R, transmitter T and winding N_3 to terminal d. The current I_1 is greater than the current I_4 and consequently a current I_1-I_4 flows from terminal d to terminal a through the winding N_1. The potentials induced in the windings of the transformer are of such value and direction as to reduce the terminal e to the same potential as terminal d so that no energy is wasted in the auxiliary resistance.

Referring to formulae (C) and comparing Fig. 3 with Fig. 1, the number of turns of the transformer windings connecting terminals a and b, a and c, and a and d may be expressed

$$N_{ab} = n_1 + n_3$$
$$N_{ac} = n_2$$
$$N_{ad} = n_1$$

Substituting these values in formulae (C) the last two formulae become

$$\frac{n_3}{n_1} = \pm \sqrt{\frac{R_1}{R_4}\frac{y}{1+y}}$$

$$\frac{n_2-n}{n_1} = \pm \frac{1}{y}\sqrt{\frac{R_1}{R_4}\frac{y}{1+y}}$$

Writing $\frac{n_1}{n_3} = r$ and $\frac{n_2}{n_3} = r^1$ we have as the design formulae for the substation of Fig 3

$$R_2 = \frac{1}{y}R_1$$

$$R_3 = \frac{1}{1+y}R_1$$

$$\frac{1}{r} = \pm\sqrt{\frac{R_1}{R_4}\frac{y}{1+y}} \qquad \text{(E)}$$

$$\frac{r^1-r}{r} = \pm\frac{1}{y}\sqrt{\frac{R_1}{R_4}\frac{y}{1+y}}$$

Another modification is illustrated in Fig. 4 in which the receiver R and winding N_2 are connected in series across terminals a and e, while the transmitter T and winding N_1 are serially connected in parallel therewith. The auxiliary resistance X is serially connected with the winding N_3 between terminal e and the junction point b of the transmitter T and winding N_1. The line L is connected between terminal a and the junction point d, between the auxiliary resistance X and the winding N_3. Condensers may be inserted in series with the winding N_1 and the auxiliary resistance X, so that direct current may flow from the line to terminal a and thence in series through winding N_2, receiver R, transmitter T and winding N_3 back to the line.

The operation during transmission is indicated in Fig. 10. Since no current flows through the receiver, the auxiliary resistance and the transmitter are in a series circuit so that a current I_3 equal to the current I_1 flows from terminal d through the auxiliary resistance X and the transmitter T to terminal b. At the point b the current divides and current I_4 flows through the winding N_1 and over the line L, back to terminal d, while a current I_1-I_4 flows in parallel therewith from the terminal b, through the winding N_3 to the terminal d. Potentials are induced in the transformer windings of such value and direction that the terminal c is reduced to the same potential as the terminal e, and consequently no current flows through the receiver during transmission.

The action while receiving is indicated in Fig. 16.

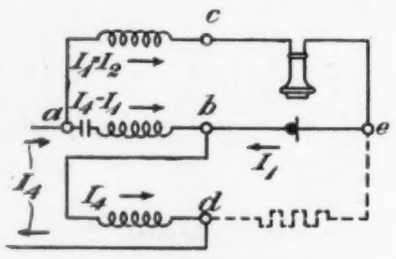


Fig. 16.

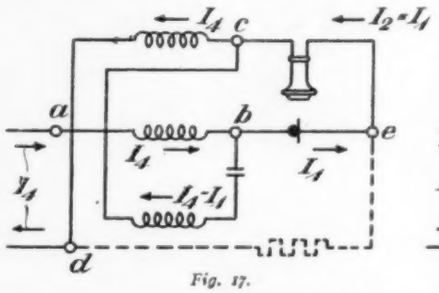


Fig. 17.

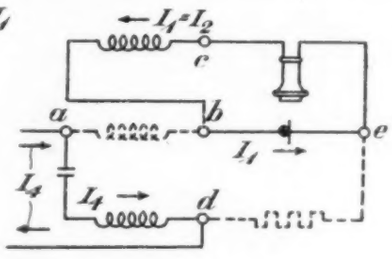


Fig. 18.

A potential applied to the line causes a current I_4 to flow from the terminal b through the winding N_3 to point d and thence over the line L to the terminal a. At terminal a the current divides and current I_1 equal to I_2 flows through the winding N_2, receiver R and transmitter T to point b, while the current I_4-I_1 flows in parallel therewith from the point a through the winding N_1 to the point b. Potentials are induced in the transformer to reduce the terminal e to the same potential as the terminal d, so that no energy is wasted in the auxiliary resistance during the receiving operation.

Public Utility Commission News

Reports Concerning the Activities of State Regulating in the Telephone Field

Alabama

ANSWERING a telegraph request last June for assistance "in the crisis that confronts the telephone companies," Samuel P. Kennedy, president of the Alabama Public Service Commission, informed Theo. N. Vail, president of the Cumberland Telephone and Telegraph Company, and F. B. MacKinnon, president of the United States Independent Telephone Association, "that the state commission will agree for the continuance of the present rates for a period not exceeding six months."

Arizona

Telegraph and telephone rates in Arizona must go back on a pre-war basis A. F. Jones, member and head of the rate department of the Arizona Corporation Commission, announced July 31.

Illinois

Proposed increase of rates of the Central Union Telephone Company in Decatur, Quincy and Rockford, as applied for by the company to the commission, were suspended until November 5, 1919, by the Illinois Public Utilities Commission.

The commission states in its order suspending the rates that the suspension is because the telephone lines will pass out of the federal control on October 1, 1919, and that in the meantime the commission will conduct an investigation into the reasonableness of the rates asked for in the petitions filed by the company with the Public Utilities Commission.

Proposed advanced rates for telephone service in Auburn and vicinity were suspended by the Illinois Public Utilities Commission until February 4, 1920, pending an investigation in the meantime into the reasonableness of the schedules by the commission.

The commission for the same reason suspended until November 30, 1919, the proposed increase of rates of the People's Telephone and Telegraph Company in Petersburg, Athens, Oakford and Tallula in Menard county.

Proposed advanced rates of the Girard Telephone Company in Girard, Macoupin county, and vicinity were resuspended until February 14, 1920. The commission in the meantime will hold hearings on the question of increasing the rates of the company.

Among other orders entered by the commission were the following:

Suspending until November 29, 1919, the application of the Vermilion County Telephone Company for approval of advanced rates for telephone service in the following cities and towns: Danville, Westville, Georgetown, Ridgefarm, Indianola, Fairmount, Fithian, Oakwood, Catlin.

Order suspending until November 29, 1919, the application of the Watseka Telephone Company for approval of proposed advance in rates for telephone service in Watseka, Ill.

Suspending until November 29, 1919, the application of the Kavanaugh Telephone Company for approval of advance in rates for telephone service in Effingham, Ill.

Suspending until November 29, 1919, application of the Galesburg Union Telephone Company for approval of proposed advance in rates for telephone service in Galesburg and Knoxville.

Suspending until November 30, 1919, application of the Central Union Telephone Company for approval of advance in rates for telephone service in Rock Island, Moline and East Moline.

Suspending until December 3, 1919, application of the DeKalb County Telephone Company for approval of advance in rates for telephone service in DeKalb, Esmond, Genoa, Hinckley, Kingston, Kirkland, Lee, Malta, Maple Park, Shabbona, Sycamore and Waterman.

Suspending until November 22, 1919, application of the Fairbury Telephone Company for approval of advance in rates for telephone service in Fairbury, Livingston county, and vicinity.

Suspending until December 3, 1919, application of the Bond County Telephone and Telegraph Company for approval of advance in rates for telephone service in Greenville and vicinity.

Authority was granted the Chicago Telephone Company by the Illinois Public Utilities Commission to continue in effect temporarily the rates heretofore authorized by Postmaster General Burleson for all telephone service in the city of Chicago and suburban towns, cities and villages served by this company outside the city of Chicago and within the state of Illinois. This order abolishes, however, the charges heretofore established by the postmaster general for the installation and moving of telephones, such charges to be governed by the rules on file with the commission and applied prior to government control. This is a temporary measure, and the matter is set for hearing before the commission at Chicago on the 12th day of September, 1919.

The Illinois Public Utilities Commission issued an order suspending until November 11, 1919, pending an investigation by the commission into the reasonableness of the same, a proposed increase of telephone rates in Freeport. The order is addressed to the Stephenson County Telephone Company.

The Cowden Mutual Telephone Company was authorized to increase its rates for telephone service in Cowden, Shelby county, to the following: Individual line stations, from $9 to $13 per year; two-party line stations, for residence, from $9 to $12 per year.

The Illinois Public Utilities Commission issued an order authorizing the Elmwood Telephone Exchange to increase its rates in Elmwood as follows: Individual business telephones from $18 to $21 per year; individual residence telephones from $15 to $18 per year; two-party residence telephones from $13 to $15 per year.

Coincident with the authorization by the public utilities commission of the purchase by the Central Union Telephone Company of the property of the Rockford Home Telephone Company, the former concern was authorized to put into effect a schedule of increased rates as follows:

Residence individual line, $33 a year; two-party line, $27; four-party, $24. Business individual line, $60; two-party, $51. Rural residence, $24; business, $33.

The utilities commission has granted permission to the Central Union Telephone Company to increase telephone rates in St. Anne. Business line rates are fixed at $30 a year and residence lines at $24.

The commission entered an order approving the toll agreement between the Central Illinois Telephone and Telegraph Company of Lincoln and the Hartsburg Telephone Exchange.

Proposed advance in toll rates for service from Winslow to Freeport of the Winslow and South Wayne Telephone Company is suspended to October 14, 1919.

Indiana

The Public Service Commission issued a modified order in the case of the sale of the Indianapolis Telephone Company and its merger with the Central Union Telephone Company, establishing the values to be placed on shares of common and preferred stock of the Indianapolis Telephone Company which are owned by persons who have not consented to the merger. The required three-fourths of the stockholders have consented, making the sale to the Central Union possible.

The value of nonconsenting preferred shares was fixed by the commission at $100 and the nonconsenting common shares at $5. The Indianapolis company was directed to deposit in the Indiana National Bank a sum sufficient to cover the appraised value of the nonconsenting shares. Provision was made also in the order that any of the nonconsenting shareholders, if willing to stand on final liquidation value, can within ninety days indorse and file their certificates with the depository.

Indianapolis will have unified telephone service within a year, according to Frank Wampler, Indiana manager of the Central Union Telephone Company, which received authority last June from the public service commission to buy the property of the Indianapolis Telephone Company for $4,250,000.

Engineers already are at work on plans for a physical connection between the two systems. They say the problem is a large one, due chiefly to the fact that the telephones of the Indianapolis company are automatic and those of the Central Union Telephone Company are manual. The Central Union Company hopes eventually to combine the two systems in such a way that both automatic and manual telephones may be used.

The Twelve Mile Telephone Company increases its rates and also increases its capital stock from $5,000 to $15,000 under an order issued by the public service commission of the state, the order being a part of the finding of the commission on the application filed by the company for permission to increase its rates and capital stock.

As a result of the investigation made by the commission and the finding from the evidence submitted to the commission at the hearing, the commission places a value of $15,000 on the company's property as a telephone utility, approves a schedule of rates sufficient to yield a return to the company of 5.7 per cent on the valuation fixed. For the use of each telephone instrument owned by a subscriber the company is ordered to pay a monthly rental of 25 cents, this payment to be made by a reduction from the bill of the subscriber of that amount. The company is also required to set aside annually for depreciation 5 per cent of the value of its depreciable property, including future additions.

The charge to subscribers has been $1 a month for all subscribers, and the company is hereafter authorized to charge net rates graduated according to the character of the service from $1.75 to $1.25 a month, these net rates to be charged as bills are paid on or before the 15th of the month in which the service is rendered.

Walter C. Brooks, owner of the Cave Telephone Exchange at Shelbyville, is authorized to increase rates. One hundred seventy-five subscribers of this line will be affected by the order.

The schedule fixed by the commission order follows: Business, single, gross $1.50, net $1.40. Residence, single line $1.40 gross, net $1.30; rural party line, per month, gross $1.25, net $1.15. The amounts are given customers when bills are paid by the tenth of the month. The residence single line rate applies to all subscribers one-half mile from exchange and for each additional half mile or fraction thereof, 25 cents is to be added per month.

Petitions asking for a general increase over the present telephone exchange rates established by Postmaster General Burleson in June were filed with the Public Service Commission by the Central Union Telephone Company for thirty-one cities and towns in Indiana. No petition was filed relative to the Indianapolis rates of the Central Union Company. The Indianapolis petition will be filed with the commission, it is understood, as soon as the consolidation of the two Indianapolis companies is consummated.

In a general way increases of from 10 to 20 per cent in exchange rates over the Burleson rates are asked by the company. In a few instances the petitions call for slight reductions in rural rates. At Alexandria, Culver, Gas City and Greenwood no increase over the Burleson rates is asked. The rates established by the Federal wire control in June were about 50 per cent higher than the rates authorized by the commission. Petitions affecting the rates at Crawfordsville and Frankfort will be filed later.

The same rates are proposed for certain groups of cities and towns.

The proposed rates for the following twelve exchanges are: Alexandria, Gas City, Greenwood, Boggstown, New Carlisle, Bunker Hill, Yorktown, Fairland, Manilla, Lewisville, Smith Valley and Rome City—Business, individual, $3; two party, $2.50; residence, individual, $2; two party, $1.50; rural, business, $2.25, and residence, $1.65.

The proposed rates for the following eight exchanges are: Auburn, Peru, Bedford (including Oolitic), Newcastle, Bloomington, Elwood, Washington and Kendallville—Business, individual, $4; two party, $3.50; residence, individual, $2.25; two party, $1.75; rural, business, $2.50; residence, $1.75. The proposed rate for exchanges having four party service is $1.50.

For the four following exchanges the proposed rates are Brooklyn, Granger, Cumberland, Osceola—Business, individual, $2.65; two party, $2.15; residence, individual, $1.65; two party, $1.40; rural business, $2; residence, $1.50.

The proposed rates for the other exchanges are:

South Bend and Mishawaka—Business, individual, $6; two party, $5. Residence, individual, $3.35; two party, $2.50. Rural, business, $3; residence, $2.

Muncie and Anderson—Business, individual, $5; two party, $4.25. Residence, individual, $2.75; two party, $2.25. Rural, business, $3; residence, $2.

Culver—Business, individual, $3; two party, $2.50. Residence, individual, $2; two party, $1.75; four party, $1.50. Rural, business, $2.25; residence, $1.65.

Vincennes—Business, individual, $4.50; two party,

$3.75. Residence, individual, $2.50; two party, $2. Rural, business, $3; residence, $2.

French Lick—Business, individual, $3.50; two party, $3. Residence, individual, $2.25; two party, $1.75. Rural, business, $2.50; residence, $1.75.

The Citizens Telephone Company of Dunkirk filed a petition with the commission asking for the following rates: Business, individual, $2.25; two party, $2; residence, individual, $1.75; four party, $1.50. According to the petition these would be the gross rates subject to 25 cents deduction if tolls are paid promptly.

The Eastern Indiana Telephone Company petitioned for the following rates at Winchester: Business, individual, $2.75; two party, $2.25; residence, individual $2; four party, $1.50. At the company's exchanges at Lynn, Fountain City, Farmland, Redkey, Ridgeville, Parker and Saratoga the following grades are asked: Business, individual, $2.25; two party, $2; residence, individual, $1.75; four party, $1.50.

Kansas

General inquiry into the charges for telephone installations and for the changing of names for telephone use and all rules of telephone service was ordered by the public utilities commission. The inquiry will affect the 700 telephone companies of Kansas.

Kentucky

An order permitting the Cumberland Telephone and Telegraph Company and the Western Union Telegraph Company to retain in effect their present schedule of rates, authorized last April by Postmaster General Burleson, has been entered by the State Railroad Commission. The order, however, stipulates that it is subject to contest at any time.

Michigan

By order of the Michigan public utilities commission telephone rates of the Michigan State Telephone Company are reduced, and rates for the Citizens Telephone Company will be made the same as the Bell rates, which will leave the Citizens' rates practically as they now stand.

Thus, the new business rate for Grand Rapids for a one party line per month is $4.50, compared with a Bell-Burleson rate of $6; two party per month $4, compared with $5; residence rate, one party, per month is $2.92, compared with a Bell-Burleson rate of $3; two party rate is $2.33⅓, compared with $2.50, and four party rate per month $1.92, compared with $2. For a farm telephone within six miles the business rate is $2.25, compared with a Bell-Burleson rate of $2.50, and residence rate is $1.75, compared with $2.25.

The Citizens' business and residence rates are the same now as the new rates of the Bell, while the farmers' rates are respectively $3 and $2, the Citizens' rates being Burleson rates.

The new rates are made retroactive to August 1 and those who paid August bills under the Burleson rate are entitled to a refund or credit on September bills.

Merger of telephone lines wherever practical is advised by the commission and permanent rates will be established as soon as possible.

The new schedule will lower rates in 182 cities of the state, the cities being divided into eight groups with Grand Rapids in group 7.

Quality of service is a factor in determining rates.

Grand Rapids rates fixed in detail are:

Business telephone, one party unlimited, per month, $4.50; business telephone, two party unlimited, per month, $4.

Residence telephone, one party unlimited, per month, $2.92; residence telephone, two party unlimited, per month, $2.33⅓; residence telephone, four party unlimited, per month, $1.92; business farm telephone, within six miles of central office, per month, $2.25; residence farm telephone, within six miles of central office, per month, $1.75; business farm telephone, more than six miles from central office, per month, $2.50; residence farm telephone, more than six miles from central office, per month, $2.

Business extension telephones not more than 600 feet from main telephone, per month, $1; residence extension telephone not more than 660 feet from main telephone, per month, 75 cents; service station (switching) for roadway companies or associations owning their own lines and telephones per station, per month, $1; minimum charge of $8 per month per line.

Commercial and branch exchanges, manual type switchboard (nonmultiple) and operator sets first posision, per month, $6; each additional position, per month, $5; manual type switchboard (multiple) the rate shall be based on the installed cost of the apparatus and associated wiring. Trunk line, 50 cents per month more than above one party business rate.

Stations located not more than 660 feet from the branch switchboard, per month, as follows: First 10 stations, each per month, $1.25; next 40 stations, each per month, $1.10; next 50 stations, each per month, 85 cents; all other stations, each per month, 60 cents; intercommunicating systems, maximum capacity 20 lines, stations to be located on same premises, subscribers to bear the cost of number and materials for cable in excess of 30 feet per station.

Trunk lines, business, 50 cents per month more than above one party business rates; residences, 50 cents per month more than above one party residence rate.

Stations, business, each per month, $2; residence, each per month, $1.50. Toll rates are also fixed, but are substantially those promulgated by Postmaster General Burleson, with some modifications. Chief of these is that the charge shall be for the air line mileage, regardless of how the call is routed by the company.

"With consolidation of the Michigan State Telephone with the Citizens Telephone properties, a telephone company could not exist under the present rates, but would have to have higher rates, probably $72 business and $42 residence," said R. D. Graham, president of the Citizens company.

"Of course, there would be lower party line rates, probably as low as $23 and $24 residence, with good service and, although rates would be higher, there would be universal service. A new arrangement would abolish charging those at a certain distance from the main exchange more for service, which is an unfair proposition. It would be a good thing to do away with the flat rate, but it is doubtful if it can be done.

Reduced telephone rates fixed for Lansing, in an order issued by the public utilities commission, follow:

One party business telephone, unlimited service, $4.25 per month.

Two party business, unlimited, $3.50.

Four party coin box business guarantee by the subscriber of 10 cents a day for local messages at five cents each with a refund of one cent to the subscriber on all local calls in excess of two a day.

Residence, one party, unlimited service, $2.50 a month.

Residence, two party, unlimited service, $2.25 a month.

Residence, four party, unlimited service, $1.75.

With Lansing in the same charge class, which is based largely on population, are Jackson, Kalamazoo and Battle Creek.

In the order the commission also fixed farm rates for cities in the fifth group which includes Lansing. They follow:

Residence farm telephone within six miles of the central office, $1.50 a month.

Business farm telephone within six miles, $2.

Business farm, more than six miles, $2.25; residence farm, more than six miles, $1.75.

Business extension on telephone not more than 660 feet from main station, $1 a month.

Residence extension telephone, not more than 660 feet from main telephone, 75 cents a month.

Installation, removal, change and other service charges, are contained in the order. These are identical with the Burleson rates for such work.

Toll rates are also contained in the order. Substantially, they are the same as those fixed by the postmaster general, with some modifications. Chief of these, is that charges for talks between towns shall be charged on the nearest air line circuit regardless of how the call is routed by the company.

The order is the most important which has yet been issued by the utilities commission. Cities are divided into eight groups, by populations, Detroit being the largest and last, with Grand Rapids as the seventh. It is the first from any Michigan authority fixing rates for the entire state.

Minnesota

The Minnesota Railroad and Warehouse Commission this fall will begin public hearings on applications by the Northwestern, Tri-State and other telephone companies, operating in Minnesota, for authority to continue in effect after December 1 the higher rates inaugurated last month under war time emergency orders of the Federal director of telephone and telegraph lines.

Commissioner Fred W. Putnam, in charge of telephone matters in the state board, indicated this following an informal conference with W. B. T. Belt president, and Guy H. Pratt, vice-president of the Northwestern Telephone Exchange Company. Although no definite understanding was talked today, it is expected the applications will be filed when the valuations of all Minnesota properties are completed by the companies and the state has checked them and finished its appraisal of toll lines.

The Federal order is effective only until December 1 and it is predicted that the state commission will act before that date.

The telephone officials declared marked improvement in service was made the last month and that increase will be noticed as operators gain experience.

Expert accountants have been sent out over the state by the Minnesota Railroad and Warehouse Commission to prepare annual reports for such telephone companies as have failed to comply with that provision of the telephone code requiring them to file annual reports with the commission. The entire expense of examining the books of such delinquent companies, including railroad far of the examiner and the expense for board and room at the town in which the office of the company is located, will be charged to the offender. In the event the bill is not paid the commissioner is authorized to institute legal proceedings to collect the same.

Several telephone companies persistently have refused or failed to make any report to the commission in compliance with the telephone act of 1915, although repeatedly urged to do so by the commission. This neglect has prevented the commission from obtaining complete data regarding telephone utilities, and naturally has worked to the disadvantage of the companies who lived up to the law. The commission was in somewhat of a dilemma in this matter, inasmuch as the act made no provision for its enforcement, but the legislature of 1919 came to the relief of the commission by enacting a law authorizing the commission to cause the desired reports to be prepared at the expense of the delinquent companies and also provided a means for collecting the bills therefor.

The Northwestern-Minnesota Telephone Company is hereby authorized to place in effect, as of August 1, 1919, the following schedule of rates at Strandquist and Karlstad, Minnesota:

Individual Line Business	$15.00 per year
Individual Line Residence	15.00 per year
Four-party Line Residence	13.00 per year
Rural Multi-party	13.00 per year
Rural Switching	4.20 per year

The practice of furnishing stockholders telephone service at preferential rates is to be discontinued and a system of accounts installed which shall be in accordance with the commission's uniform system of accounting.

The Clearwater Telephone Company is permitted to place in effect, as of August 1, 1919, the following schedule of rates at Clearwater, Minnesota:

Individual Line Business	$1.75 per month
Individual Line Residence	1.50 per month
Four-party Line Residence	1.25 per month
Rural Multi-party	1.50 per month

It is further ordered that the petitioner classify the service in accordance with the rate paid by the subscriber as designated in the rate schedule.

The Avon Rural Telephone Company is permitted to place in effect, as of August 1, 1919, a rate of $1.50 per month, payable quarterly in advance, with a discount of 75 cents if paid during the first month of the quarter; 50 cents if paid during the second month of the quarter, and 25 cents if paid during the third month of the quarter.

The Rochester Telephone Company is permitted to place in effect, as of August 1, 1919, and to continue for a period of one year, the following rates for local exchange service, in the city of Rochester, Minnesota:

Individual Line Business	$3.75 per month gro.
Two-party Line Business	3.25 per month gro.
Individual Line Residence	2.25 per month gro.
Two-party Line Residence	2.00 per month gro.
Four-party Line Residence	1.75 per month gro.
Rural Multi-party (company owned)	1.75 per month gro.
Rural Switching per Station	4.20 per annum net

Such other rates for the various classes of service as covered by the petition, are also hereby approved.

A discount of 25 cents per month to be allowed on all gross rates if paid on or before the 15th of the month in which the service is rendered, except that rural multi-party rates are payable quarterly in advance, with a discount of 75 cents if paid on or before the 15th day of the first month of the quarter; a dis-

count of 50 cents if paid on or before the 15th day of the second month of the quarter, and a discount of 25 cents if paid on or before the 15th day of the third month of the quarter.

Before the expiration of one year, if not otherwise ordered, the Rochester Telephone Company is to present a physical valuation of its properties, together with operating statements to the commission, for the purpose of further substantiating the rates allowed.

The Wright County Telephone Company is permitted to place in effect, as of July 1, 1919, the following schedule of rates, at Waverly and Montrose, Minnesota:

Individual Line Business	$2.00 per month net
Business Extension	.75 per month net
Individual Line Residence	1.50 per month net
Four-party Line Residence	1.25 per month net
Rural Multi-party	1.50 per month gro.

All rates payable in advance.

On rural multi-party rates, a discount of 75 cents will be allowed if paid on or before the 10th day of the first month of the quarter; 50 cents if paid on or or before the 10th day of the second month of the quarter, and a discount of 25 cents if paid on of before the 10th day of the third month of the quarter.

The Glyndon Telephone Company is permitted to place in effect as of September 1, 1919, the following schedule of rates for local and rural telephone service in the village of Glyndon, Minnesota:

Individual Line Business	$2.25 per month gross
Individual Line Residence	1.75 per month gross
Rural Multi-party	1.75 per month gross
Extension Telephones	.50 per month net

All rates to be billed gross, except where quoted net. All gross rates are payable in advance with a discount of 25 cents if paid on or before the 20th of the month in which the service is rendered, except that rural rates are payable quarterly with a discount of 75 cents if paid on or before the 20th of the first month of the quarter; a discount of 50 cents if paid on or before the 20th of the second month of the quarter, and a discount of 25 cents if paid on or before the 20th of the third month of the quarter.

The Home Telephone Company of Grand Meadow is authorized to place in effect the following schedule of rates, as of July 1, 1919:

Individual Line Business	$1.75 per month gross
Two-party Line Business	1.50 per month gross
Individual Line Residence	1.50 per month gross
Two-party Line Residence	1.25 per month gross
Rural Multi-party (company owned)	1.25 per month gross
Extension Bells	.15 per month net

All rates to be billed gross except where quoted net. A discount of 10 cents per month to be allowed on all gross rates if paid during the month following that in which the service is rendered, except that rural multi-party rates are payable quarterly, and a discount of 10 cents per month will be allowed if paid during the quarter in which the service is rendered.

The Brooten Telephone Company is permitted to place in effect as of September 1, 1919, the following schedule of rates for telephone service in the village of Brooten, Minnesota:

Individual Line Business	$2.25 per month gross
Individual Line Residence	1.50 per month gross
Rural Switching Charges	.25 per month net

A discount of 25 cents per month is to be allowed from the above gross rates if payment is made on or before the last day of the month in which the service is rendered.

Missouri

The State Public Service Commission has granted an increase in telephone rates to the Jefferson City Telephone Company. Business telephones are increased from $2.65 to $3.15 a month and party lines from $1.40 to $1.55 a month. A discount of 15 cents is allowed on monthly bills settled before the 10th of each month. Single residence telephone rates were not changed.

The commission has issued an order "that the schedule of increased rates for Hannibal as filed by the Southwestern Bell Telephone Company, to be effective January 1, 1919, be and the same is hereby stricken from the files of the commission and that this proceeding be and the same is dismissed."

The State Public Service Commission has set September 24 as the date for hearing all the telephone companies seeking to maintain the service connection charges fixed by the Postmaster-General last spring.

The Kinloch, the Kansas City Telephone Company and all Independent lines that were formerly under control of the government, as well as the Bell system, are involved in this hearing.

The Kansas City, the Kinloch and the Independent lines did not increase their local telephone rates and they are not concerned in the order of the commission on the Bell Telephone Company to show cause why the charges authorized by the commission prior to the government taking control of the lines should not be restored.

The Bell increased its local rates in St. Louis and in some sixty cities of the state approximately 20 per cent.

The big companies and the Independent lines affected by the charge are all contending that it is reasonable, in view of the general advance in the cost of labor and materials, and should not be disturbed. The Bell company is also contending that its increased charges for telephone service, as well as service connections, should be maintained and on much the same grounds.

The Johnson County Home Telephone Company of Warrensburg, filed an application with the commission for authority to purchase the exchange of the Bell company at Warrensburg for $30,000 in installments of twenty payments. The consent of the Bell company was also filed. The local company has a capital of $15,000 and no debts outside of current expenses.

Nebraska

The State Railway Commission granted authority to the Callaway Telephone Company of Callaway, Neb., to charge a monthly rate of $2 for local telephone service furnished to its subscribers after the metallic battery system is installed. The franchise of the city under which the company operates provides for such a rate when the new system is installed. The company is also authorized to collect 25 cents per call made between the house of 10:30 p. m. and 5:30 a. m. of the following day, and interest at the rate of 10 per cent per annum on delinquent accounts of $50 or more.

Authority was granted the Moorfield Farm and

Branch Telephone Company by the state railway commission to increase its schedule of rates for business service to $2.25 per month gross, $2.00 net, and residence and farm line rates to $1.75 per month gross, $1.50 net. The new schedule was to become effective on August 1. The commission further orders that after all proper operating expenses and maintenance expenses have been paid or provided for, the company shall pay at its option not more than 8 per cent dividends on its outstanding stock. Thereafter all surplus are to be used for betterments of existing property or shall be held in surplus against unrealized depreciation. The present rates of the company are $1.50 per month net on business service and $1.00 per month net on residence service.

The Surprise Telephone Company of Surprise has filed an application for increased rates with the state railway commission. The company wishes authorization to establish rates of $1.50 on farm lines and $1.25 on town residence two-party lines at both Surprise and Rising City. With the increased rates asked they intend to give full service of each exchange instead of serving both towns with one exchange as is done at present. The present rates are $1 for both classes of service with the single exchange.

Permission had been permitted the Wyoming and Nebraska Telephone Company to increase its rates 25 cents for individual and 50 cents for business telephones. The company has exchanges at Chadron, Cody, Crawford, Gordon and other northwestern Nebraska towns.

The Seneca Telephone Company, with 26 subscribers and 18 stockholders, has been granted permission to make a rate of $2.50 per house per month. The line extends 43 miles through the sand hills and is used almost totally by ranchmen in that section.

It has been agreed that the Ord Independent Telephone Company system will be sold to the Farmers Telephone Company at a price set by the state railway commission.

The commission has authorized telephone companies to charge Burleson installation rates until a hearing October 15, when new state rates will be determined.

The Farmers' Telephone Company of Dodge County was given authority to increase rates by the state railway commission.

A decision was handed down some time ago by the state railway commission, holding that a mutual farm telephone line, which has regular switching arrangements with common carrier telephone companies, also becomes a common carrier, will be of interest.

The Southern Elkhorn Telephone Company running out of Norfolk was built by a number of farmers by subscription. It has no rate schedule, but asses the owners in proportion to the expense. The owners refused service to Fred Doxtrader, who lived on the line. Doxtrader claimed the owners were Germans and for that reason refused him service. The owners claimed Doxtrader was in the berry and vegetable business, and was therefore refused service, as the other telephones were for residence purposes.

However, the mutual line has switching arrangements with the Norfolk exchange and receives calls for points on other than its own line, and the commission claims it then becomes a public utility, and issued an order that a telephone for Doxtrader must be installed.

New Mexico

The Mountain States Telephone Company rates will be considered at a hearing set for September 15. The telephone company filed the new rates with the commission on June 15, while the Western Union never filed the new rates until its application was filed the last of July. The commission proposes to go into detail of rates at these hearings that it may be able to decide intelligently.

New York

The Public Service Commission for the Second District held its first and to all intents and purposes, its last inquiry into the reasons for alleged bad telephone service in New York City on August 8. It listened to a long statement by F. H. Bethel, vice president of the New York Telephone Company, in which he admitted the service could not be much worse and promised to make every effort to improve it. After Mr. Bethel had been cross-examined the commission adjourned the hearing without date.

Ohio

Formal application of the Hamilton Home Telephone Company for authority to sell the property to the Cincinnati and Suburban Bell Telephone Company was filed last month. The company was directed to file an inventory and the commission, when it approves the consolidation, will approve the present rates.

Oklahoma

Because the owners are unable to make expenses at the old rates, the Sand Springs Telephone Company secured permission to raise rates the first of August to $3 per month for business telephones and $1.75 for residence telephones.

Utah

The public utilities commission of Utah, after a conference with officials of the Mountain States Telephone & Telegraph Company, decided to order a physical valuation of all the property of the company in the state. This is to be made at the company's expense, and under the rules formulated by the commission, and will be under supervision of the commission's engineers and auditors.

The physical valuation and inventory will be used by the commission as a basis in determining a reasonable rate for telephone service in Utah. It is believed the entire process will be completed by November 30, until which time the present telephone rates, fixed by Postmaster-General A. S. Burleson, remains in effect. The act of congress which provides for turning back the company properties from the government to their private owners by August 1, also provides that the present rates shall remain in effect for four months longer, or until such time as the state commissions may determine the fair rate for the companies.

The conference followed a petition from the com-

pany, presented a few days ago, in which it was asked that the present rates be continued in effect. There is also pending before the commission a petition for an increase from the rates formerly in effect, as regards service connection and removal charges. Hearing on that petition was begun, but was indefinitely postponed when the government took over the properties.

Virginia

Notice has been sent to all subscribers of the Chesapeake and Potomac Telephone Company that they have asked the State Corporation Commission to look into the matter of telephone rates, with the view of getting more revenue.

A hearing has been set for November 9. The commission must fix the rates before December 1, as on that date the scale now in vogue will be inoperative.

Washington

The Washington State Public Service Commission at Olympia issued an order continuing the rates in the state pending protest and investigation.

Chairman E. F. Blaine of the Public Service Commission said the order of the commission was issued in order to protect the smaller telephone companies of the state, of which there are probably two hundred. The commission has the authority to waive the usual thirty-day notice for filing of new schedules and to permit the filing with one-day notice. This was done in the order. Mr. Blaine said that the commission's order was designed to prevent chaos in the service of the smaller utilities that could not, in the face of increased costs, operate at the pre-war basis. Under protest of the present rates, he said, the burden of the proof of inability to operate under a reduction will be on the utility company in event of protest.

Wisconsin

July 31 the railroad commission issued an order to all telephone companies restoring the rates in effect July 31, 1918, when the postoffice department took over the wires.

The order applies to all telephone companies which have not signed compensation contracts with the federal government, or which did not file claim with the postmaster-general before June 20, 1919, for compensation, other than net earnings since July 31, 1918.

No change in the restored rate will be made by the commission unless telephone companies apply in the usual manner.

The notice of the commission announces that "service connection charges" and "charges for moves and changes" are null and void and the companies are ordered to discontinue their collection.

Employes Organize

Representatives of 16,000 workers in all departments of the Southern Bell Telephone Company system in nine states completed the organization of an association at Atlanta, Ga., after a three weeks' convention at the Ivy exchange. It will serve as a medium between the company and employes.

Two Atlantans were elected officers of the association, to be known as the Southern Association of Bell Telephone Employes. Lewis D. Sharp, secretary of the company's benefit fund, was elected president and E. L. Tarry, of the auditing department, general secretary.

The division chairmen are C. A. Long, Atlanta; W. A. Steadman, Birmingham; R. V. Davis, Charleston; J. H. Roscoe, Savannah; L. A. Farmer, New Orleans; A. G. Walker, Knoxville; C. B. Watson, Danville, Ky., and William Baird, Evansville, Ind. These officers are elected to serve until December.

It is provided in the constitution of the organization that those eligible to membership shall be all white employes below the rank of division superintendent who have reached the age of 16 years and who have been with the company continuously for six months. The general assembly of the association will hold annual meetings in December of each year, and will consist of the president, the general secretary, each division chairman, three delegates from each division and three delegates from the general offices. They meet next in Nashville.

The purposes of the organization are best set forth in this excerpt from the constitution:

The purpose and objects of this association are to promote the welfare of its members, to develop a clearer undestanding of the problems mutually affecting the management and the employes, to continue the existing friendly relationship between the employes and the company which will permit of amicable discussion and adjustment of questions or problems pertaining to working conditions and wages; to provide a simple, effective and expeditious way whereby such employes as so desire may collectively or individually present such questions to the company; and finally to encourage and further develop efficiency and a high spirit of earnest co-operation.

The association recognizes and affirms the fundamental principle that any employe has the right to bargain individually as to the terms and conditions of his or her employment and accordingly it is not the purpose or intent of this association to interfere with or hamper and employe in the exercise of such rights, or with the administration of the company's affairs.

The association believes that the interests of the management and the employes are common and not opposed, and further that the objects of industry are not only material prosperity, but also the advancement of social well being, and that in the pursuit of these objects the interests of the public are paramount and affirms the principle that all differences between employes and management of a public utility should be settled by conference. By so doing the interests of the public will be cared for, the well being of employes fully guarded, and management and capital adequately recognized.

Cares for Operators During Riots

The Chicago Telephone Company, in order to maintain uninterrupted service during the race rioting and street car strike, in Chicago, obtained hotel accommodations in the loop for the hundreds of operators in the different loop exchanges. Besides caring for them as to hotel conveniences the company also made it pleasant for employes who were compelled to remain in the loop in their off-hours. Those who were not working were entertained by the company at the Majestic theater, Mr. Tisdale, manager of the latter house, having been requested to reserve 500 seats.

"The French Flasher"

The French Battery and Carbon Company, Madison, Wis., has entered the ranks of the publishers with a snappy little house organ entitled "The French Flasher," Vol. 1, No. 1 of which appeared in July. The first number tells of the organization of the company's new employees' association, and carries a picture of the happy family assembled on the factory lawn, apparently engaged in banqueting. The balance of the paper is filled with records of local doings and the personal items that help to bind a force of workers together.

Of Interest to the Trade

H. A. Harris, General Manager of Automatic; W. F. Benoist, Sales Manager

Vice president and director of Automatic Electric Company since 1905 and for the past four and a half years sales manager, H. A. Harris has recently been appointed general manager in charge of all the activities of the organization, and his first official act was to make W. F. Benoist his sucessor as head of the sales department.

Graduating from the University of Michigan in 1899, Mr. Harris became associated with his father, Joseph Harris, founder and for many years president of Automatic Electric Company. For the past ten years the younger Mr. Harris has concerned himself in every phase of the business, thus acquiring a familiarity with its broad aspects as well as its detailed operation, which peculiarly fit him for his new duties.

During the time he was sales manager, a number of large and important operating units have adopted the Automatic equipment and each year has seen the trend in this direction becoming stronger.

This expansion has been notably rapid during the current year. The International Telephone Sales & Engineering Corporation has entere into a contract with the Automatic Electric Company for $15,000,000 worth of equipment covering a period of five years. In addition over 12,000 lines of apparatus has been ordered during the past few weeks, to increase the capacity of the Cuban Telephone Company's Havana system by 50 per cent, and to add substantially to the Automatic exchanges in a number of other cities, such as Lincoln, Neb., Erie, Pa., Edmonton and Calgary, Can., Muskegon, Mich., and a number of others. A very substantial amount of apparatus is also in course of construction for interconnecting the automatic and manual systems at Minneapolis and St. Paul.

The Automatic Electric Company is greatly expanding its production capacity to meet the increased volume of business, and Mr. Harris will hereafter devote his entire attention to the larger problems of coördinating this organization and the efficient operation of all its departments.

W. F. Benoist, whom Mr. Harris appointed as his successor as sales manager, has devoted 20 years of activity to telephone work. During that time he has not only acquired a wide personal acquaintance in the field, but has also familiarized himself thoroughly with all phases of its activities.

He entered the telephone business as assistant secretary of the Kinlock Long Distance Telephone Company, of St. Louis, Mo., thus coming in close contact with the construction and operating side of the work. He was later associated as a consulting engineer with Charles H. Ledlie, of St. Louis, and as such was concerned in the construction and operation of a number of large and important telephone plants throughout the West and Southwest.

In 1909 he became assistant to the sales manager of the Automatic Electric Company, and during the intervening ten years has thoroughly familiarized himself with Automatic equipment and its place in the telephone industry.

In line with the general policy of expansion announced by the Automatic Electric Company, the sales department will extend and increase its efforts in all directions, but will not in any way deviate from its former custom of extending every possible assistance to the operating units which desire to study the adaptation of Automatic equipment to their needs.

General Manager H. A. Harris.

Sales Manager W. F. Benoist.

The company's sales staff is made up of men thoroughly trained and experienced in Automatic operation and also intimately in touch with the problems confronting the telephone companies of the country. It is the company's desire to place this staff universally at the service of the telephone operating organizations and Mr. Benoist and his associates hold themselves always ready to co-operate to the fullest extent in carrying out this purpose.

Electrical Exposition Will Re-open Grand Central Palace

Having done its bit by serving effectively as an army hospital, Grand Central Palace, New York City's largest exhibition building, is about to resume its normal peace-time status. Its return to the field of industrial exhibitions will be signalized on September 24 when the Electrical Exposition opens there for its customary run of ten days. Excepting last year, when the great electrical industry was too busy helping win the war to take time to show its latest inventions to the public, this exposition has been held annually in New York since 1907.

A large force of skilled workmen is now busily engaged in restoring the exhibition floors of Grand Central Palace to their original state. Already the numerous partitions built in making hospital wards have been removed, as well as the big theater constructed on the main floor for the entertainment of the patients. An idea of the extent of this interior reconstruction is had from the fact that as many as 3,700 bed patients have been there at one time, and besides the wards there

were offices, reception rooms, operating and dressing rooms, mess halls, kitchens, store rooms, etc.

One hospital feature will remain as a part of the Electrical Exposition. This will be an electro therapeutic exhibit by the Medical Department of the U. S. Army. It will serve to train doctors in the many new uses of electricty in the therapeutic field and to enlighten the public on the benefits possible therefrom. As a whole this year's Electrical Show will be more varied and interesting than heretofore because this time it will disclose two full years of high-tension developments in the electrical field.

Vail Makes Statement

Theodore N. Vail, chairman of the American Telephone and Telegraph Company, in a report to stockholders of the company says:

"When the agreement with the government, covering the compensation, etc., under federal control, was made, you were told that it was based primarily on the production of your property and of your organization, the compensation being secondary so long as it was sufficient to meet the obligations of the corporation.

"There has been no policy adopted by the postmaster general during the period of federal control which was not in the interest of the service and with which your organization has not been in full accord. This cooperation has resulted in the maintenance of the service at the highest standard possible under the extremely arduous conditions.

"It is gratifying now to state that your property has been maintained and will be returned in as good physical condition as though it had never been out of our possession. Of your organization the same can be said, barring the effect of the indeterminable disturbances which always accompany radical changes, and barring the effects of the decimation of our force by war service (some 15,000 of our best employes were taken into national service) and that caused by the impossibility of immediately meeting the abnormal wages paid in other lines of industry.

"These necessarily affected our service, through lack both of sufficient and of well-trained employes to cope with an abnormal increase in demand for service. This is gradually being remedied by the return of our employes and officers from war service and by the gradual increase of our wages to meet existing conditions.

"The applications for rate increases which were, as a rule, being favorably acted upon, until commission action was suspended by federal control coming into effect, have been replaced by the readjustment of rates ordered by the postmaster general which have now become effective."

Concerning new equipment it is interesting to notice that the company is now installing and making use of automatic devices which it formerly held to be impractical. Regarding this Mr. Vail says:

"Machine switching is fast coming into use under certain conditions, and while it may never take the place of manual operating, it will relieve the tension in many places by taking up a considerable part of the growth.

"Increased operating charges will be largely met by getting better service from the same or even less exertion of personal effort, aided and supplemented by mechanical appliances, and by the revenue from the increased services of now unused facilities and from additional services over the same plant.

"Our dividends to share holders, practically fixed on our volition long since, are now fixed under control and regulation at reasonable rates, and the rates we have been paying are generally considered as reasonable. The general policy of establishing a certainty and security for reasonable capital requirements, so soon as it is recognized by the public as a fixed policy, will be of infinite public advantage. The more certain the public believe investment in any securities to be, the more they will pay for them and the cheaper will be the price that will have to be paid for new money.

"There never has been a time when the conservative policy, which has been the rule of the system, has so justified itself as the present. Under the policy there has been established a national system by and with the consent of the public served and of all controlling bodies or officials, and the public served now fully recognize the absolute correctness of the policy of one interdependent, intercommunicating system.

"While there is, and is to be hoped there always will be, local opposition, to create another national system or anything approaching it would be a physical impossibility and perhaps an economic disaster to the promoters. There is already one and one-third billions invested in the property controlled by your system, and to reconstruct or construct another would require over two billions and take at least 10 years, while at least another billion would be required to meet the growth during that 10 years."

Make Good on Service

Return of the telegraph and telephone lines to their owners by Postmaster General Burleson means the opportunity of the private owners to make good.

We have seen what may happen—what has happened—to public utilities under government control. The trend of public comment has been that of harsh criticism of federal direction and of belief that private ownership is infinitely superior. The action of the private owners must now demonstate the correctness of the criticism.

The telegraph and telephone companies will find themselves confronted with grave problems of readjustment. All the ills of government control will affect in some degree the immediate future of the service. The companies must eliminate the evils and appropriate the virtues in such a way as to assure the public of better service than it has had during the war, while at the same time settling the various disputes aroused in the last year.

It is probable the misfortunes of telephone and telegraph service will be charged to the private owners in spite of the fact that they have been only remotely responsible. This is one of the things the owners must bear. The public will expect good service and will be impatient with explanations.

The real patriotism of the owners will appear not so much in turning over the lines to the government and assisting in their operation but in straightening out the kinks, now that they have their properties back again.

On the success of the companies in resuming efficient management of the lines will depend the attitude of the public toward large utilities. If service is good we will be near the adjustment of a great problem. If it is bad we will continue to remain on stilts in one field of endeavor at least.—Chicago Tribune.

Brevities of the Business

The Activities of the Whole Telephone Field Told in Short Paragraphs

PERSONAL NOTES

Charles W. McKay, for some time appraisal engineer for the industrial engineering firm of Cooley & Marvin Company, Boston, Mass., is now chief appraisal engineer of L. V. Estes, Inc., of Chicago. In this capacity he is prepared to make appraisals and valuations of Independent telephone properties. Mr. McKay needs no introduction to the field, as telephone engineering and appraisal work has been specialized in by him since graduation from Cornell University in 1906 with a degree of M. E. After several years of varied experience in appraisal work with the New York & New Jersey Telephone Company, when that company, together with all of the up-state Bell companies, was absorbed by the New York Telephone Company, Mr. McKay was assigned to special work for the consolidated company, inspecting a number of newly-acquired properties, making plans for cut-overs, etc. In 1911, he was stationed at the company's headquarters in New York, subsequently being appointed engineer for the borough of Queens. Severing his connection with the New York Telephone Company early in 1912, Mr. McKay was for a time associated with Henry Floy in the capacity of assistant engineer. In the summer of 1913 he became engineer to the McCall & Clark Company, efficiency experts of New York, and in October of that year he affiliated himself with McMeen & Miller of Chicago. The major portion of Mr. McKay's time with this well-known firm was spent on problems involving the appraisement of telephone properties. After leaving the employ of McMeen & Miller he was associated with the Central Union Telephone Company in valution work. He later accepted the appointment as appraisal engineer for Cooley & Marvin.

The new general manager of the LaPorte Telephone Company, LaPorte, Ind., Frank B. Newman, has arrived from Indianapolis and has taken active charge of the local plant.

It is announced by the Southwestern Bell Telephone Company that James C. Thornton has been appointed district manager at St. Joseph, Mo., and will take up his duties at once. He will replace G. V. Ross, acting district manager, who will return to St. Louis. Mr. Thornton is a telephone man of wide experience, having been general manager of the Buffum Telephone Company for the last fifteen years, with headquarters at Louisiana, Mo. The Buffum Telephone Company operates in Lincoln, Pike, Audrian, Montgomery, Calloway and Randolph counties, and is a connecting company of the Bell system.

Harry Young, who has been managing the Conroy Telephone exchange at Marengo, Ia., has resigned, to take effect September 1.

C. F. Mason, district commercial traffic superintendent of the Southern California Telephone Company and one of the most popular men in business circles in the Southland, has tendered his resignation to take effect on September 1. It was announced that shortly after that date Mr. Mason will embark in the stock and bond business. Mr. Mason has been in the service of the Pacific Telephone and Telegraph Company for the past 12 years. He came from San Francisco as superintendent of telegraph and later took charge of the business end of the Home Telephone Company. During the period of the war Mr. Mason refused several exceptionally attractive opportunities for self advancement, in order as he says, to "do his bit" in the winning of the war. He will engage in the new venture after a vacation of several weeks.

Wade Milam, who has been foreman of the plant of the local Southern Bell Telephone exchange at La Grange, Ga., has resigned his position with that corporation and will assume an active part in the management of the Milam Brothers Soda Company and Drug Company. Mr. Milam has been connected with the telephone company in La Grange ever since it was established and has given efficient service. C. E. Tucker, of Covington, will take Mr. Milam's place.

George Miller, of Norfolk, Nebr., has been transferred to Columbus by the Nebraska Telephone Company to take charge of the company's business at this point.

With the relinquishment of government control of the Pacific Telephone and Telegraph Company many changes have been made in the personnel of the administrative staff. William Hearn, V. V. Stevenson and J. A. Forehand, general superintendents in San Francisco, Los Angeles and Seattle, respectively, have been relieved. Hearn will be succeeded by A. B. Richards, who was Hearn's predecessor. A. St. Louis will take Stevenson's place. Forehand will be succeeded by a company executive from Des Moines.

E. J. Pyne, who for several months past has been local manager at Deadwood, S. Dak., for the Nebraska Telephone Company, has been promoted to the position of manager at Rapid City.

J. R. Coble has been elected manager of the Gays Mutual Telephone Company at Gays, Ill. He succeeds Mr. Guinup, who resigned after a few months at the job.

Earl F. Francis, manager of the Portage county branch of the Ohio State Telephone Company, has resigned. Mr. Francis has been with the Ohio State Company since 1914 and associated with the Independent companies since 1905.

Mason E. Reynolds, for the past 20 years manager of the Citizens Telephone exchange at Mason, Mich., has resigned, to take effect as soon as another man is engaged to take his place.

L. E. Bacon of the firm of Eckerd & Bacon of Hazelhurst, Ill., is the new manager of the Polo Mutual Telephone Company and entered upon his duties August 1.

Elmer Speaker, who has been manager for the McAlester, Okla., district of the Southwestern Bell Telephone Company for several years, has been promoted to the management of the Okmulgee district, effective August 15. He will be succeeded at McAlester by Joseph Higgins, of Hugo, now manager of the Hugo district.

E. V. Cooper, who has been manager of the commercial department of the Nebraska Telephone Company's exchange at Central City for a number of years, has been notified of his transfer to Holdredge, Nebr., where he will have charge of a territory which will include seveen exchanges. E. L. Dryer, recently discharged from the naval aviation service, will replace him.

The Iowa Telephone Company has made some changes in the McGregor office. C. B. Raney, who has been the efficient manager for several years, has been transferred to another office. His successor is R. J. Hopley of Fort Madison.

Earl F. Francis, manager of the Ravenna branch of the Ohio State Telephone Company since August 16, 1918, has tendered his resignation.

A. T. Ross, with headquarters in Dublin, is now the local manager of the Southern Bell at Wrightsville.

E. H. Bails, who for the past several years has been in charge of the Holdredge office of the Nebraska Telephone Company, has been made manager of the Norfolk district for the same concern. E. V. Cooper of Central City will succeed Mr. Bails as manager of the Holdrege office.

F. E. Hotchkiss of Mason City is the new manager of the Western Electric Telephone System at Estherville, Ia. He succeeds L. A. Blair, who has resigned in order to go to Twin Falls, Idaho.

C. Burr Forest, who recently resigned as member of the public utilities commission, has been appointed manager for the Fremont Home Telephone Company at Fremont, Ohio, succeeding George Seaman. Mr. Seaman will remain with the company as secretary and office manager.

William Savage, manager of the Ridgefarm (Ill.) telephone exchange, resigned his position. Charles Stevenson, who has been with the telephone company for a number of years, was appointed to fill the vacancy.

NEWS FROM THE FIELD

CALIFORNIA

The telephone strike which has tied up service in San Francisco and every city along the Pacific coast for five weeks, has been officially ended.

The state railroad commission has before it a request for an increase of telephone rates in Long Beach and San Bernardino by the Union Home Telephone and Telegraph Company. Increases of 50 cents a month on business telephones and 25 cents on residence telephones are asked. The company bases its request on an estimated income of $293,426.23, with an expenditure of $283,818.22 for the year beginning August 1. It figures to obtain a revenue of $9,608.01 from the increased charges if allowed. Officials claim the company has operated for the past ten years at an annual loss of from $5,000 to $19,000, and is unable to set aside a sinking fund of two per cent a year or to pay the interest on its bonded indebtedness. Strenuous competition is given as the cause.

GEORGIA

The Southern Bell Telephone and Telegraph Company has applied to the Railroad Commission of Georgia for authority to continue to charge as maximum rates, for a period of one year from December 1, 1919, the scale of installation, local exchange and toll charges made effective by the Postmaster General during Federal control, for said company, on Georgia intra-state traffic and at local exchanges.

D. H. Dinox of Pineora has bought the Pineora-Guyton Telephone Company, with lines all through Effingham county and in Screven and Bulloch counties. Mr. Dixon intends to do over the entire system, the former owner having begun the work, assuring the patrons of good service.

Increases ranging from 50 cents to $1 per phone are asked by the Bowen Telephone Company, which operates eight exchanges in south Georgia.

ILLINOIS

On account of the telephone lines passing from the control of the government, the Illinois Public Utilities Commission recently issued an order suspending the proposed increase in rates of the De Kalb County Telephone Company in the cities and towns served by it, until December 20, 1919. In the meantime the commission will investigate the reasonableness of the proposed increase. The company asks the same rates that the government granted to it.

The Decatur Telephone Company and companies in more than 50 cities and towns in Illinois filed petitions with the Public Utilities Commission recently, asking that present rate schedules be continued in effect by the state commission when the lines revert from federal to state control. Among the cities affected by the petitions were Mt. Vernon, Peoria, Moline, Rock Island, Champaign, Urbana, Quincy, Danville and Galesburg.

Four telephone companies of Calhoun county announces that social conversations over their lines will be strictly limited to five minutes; for each additional five minutes ten cents will be charged.

Proposed advance in rates for telephone service in Dana, Lostant and Rutland, La Salle county, by the Central Illinois Independent Telephone Company, was ordered suspended until November 5, 1919, by the state Public Utilities Commission.

The Utilities Commission of Springfield has authorized the sale of the North Millbrook Telephone Company to the Brimfield Telephone Company for $1,000.

The Central Union Telephone Company has given notice to the public that it has filed with the Public Utilities Commission of Illinois schedules which will change the rates for telephone service in Quincy, County of Adams, and that the said change of rates involves an increase in the rates for all general classes of service.

A deal has been closed by which the Central Union Telephone Company at Kankakee absorbs the Eastern Illinois Telephone Company, and also the local exchange known as the "Independent." The Eastern Illinois Telephone Company was organized in 1904 and operated 40 miles of toll lines and served 2,300 subscribers.

A joint petition was filed by the Chesterfield Telephone Company and the Medora Telephone Company with the Illinois Public Utilities Commission, asking for the approval of the sale to the Chesterfield Telephone Company by the Medora Telephone Company of the latter's property. The Chesterfield Telephone Company also filed a petition asking for authority to issue $12,000 of first mortgage bonds.

The Public Utilities Commission has notified the village board of Dwight that an application has been filed with that body for an increase in telephone rates at Dwight.

INDIANA

An increase of fifty cents a month for business telephones is the only change that will be made in local telephone rates if a petition now pending before the Indiana Public Service Commission is granted. The new schedule of rates, which the Central Union Telephone Company seeks to make effective in Washington, would increase individual business telephones to $4.00 a month and two-party business telephones to $3.50 a month, an increase of 50 cents. Other slight changes are made in private branch exchanges but there are no such private branch exchanges here and therefore they would not be effective in this city.

The Central Union Telephone Company has filed with the Public Service Commission two petitions for rates in Frankfort and Crawfordsville. The proposed increased rates for Frankfort are: Business telephone, $3; residence telephone, individual, $2; two party, $1.50; rural telephone, $1.50. The proposed rates for Crawfordville are: Business, $3.50; residence, $2; rural, $1.50.

The Public Service Commission has been appealed to by the Kendallville Telephone Exchange asking that local rates in Kendallville and Rome City be boosted again. The rates asked for are as follows: In Kendallville the petition calls for proposed rates as follows: Business individual, $4, present rate $3.50; two-party business $3.50, present rate $3; residence, individual, $2.25, present rate, $2; two-party, $1.75, present rate, same; four-party, $1.50, present rate, same. Rural: Business, $2.50, present rate, $2; residence, $1.75, present rate, $1.50. The schedule for Rome City follows: Business, individual, $3, present rate, $2.75; two-party, $2.50, present rate, $2.25; residence, individual, $2; present rate, same; two-party, $1.50, present rate, same. Rural, business, $2.25; residence, $1.65.

The systems at South Bend and Mishawaka have been merged. The first telephone exchange in South Bend was established in 1880.

The first petition from a telephone company asking to continue the increased Burleson exchange rates was filed with the Public Service Commission recently by the Louisville Home Telephone Company, which operates exchanges in New Albany, Sellersburg and serves patrons in Clarq, Harrison and Floyd counties. The company asks that it be permitted to continue the increased charges until the commission conducts a hearing on the petition.

Petitions were filed with the Public Service Commission recently by three telephone companies asking for increases in rates. The Citizens Telephone Company of Upland asked for a primary business rate of $2.50 and residence rate of $1.75. The Edwardsport Telephone Exchange and the Freelandville Co-operative Telephone Company asked for a general revision of rates.

The city of Ft. Wayne through its legal department recently petitioned the Public Service Commission to order the Home Telephone and Telegraph Company to restore the telephone rates schedule in effect at Ft. Wayne prior to May 1. Since that time the telephone rates have been based on a higher level ordered by the federal telephone administrator.

At a meeting of the stockholders of the Farmers Mutual Telephone Company at Vevay recently new directors were elected to build up the company's interests and establish the organization on a new business footing. They were Al Lance, Wm. Patton, Wm. Shaw, Chas. Smith, Clarence Stevens, Mitchell Detraz and John Lock. These directors will elect a manager who will superintend the erection and repair of lines and build up the service to the greatest possible degree.

South Bend city may lose its free telephone service. The Bell Company is demanding pay for city telephones.

Telephone patrons of Whiteland, Bargersville, Trafalgar and Needham exchanges in Johnson county have organized to notify managers that unless service is improved and rates reduced they will remove their telephones. This decision was reached at mass meetings in Bargersville and Whiteland. Meetings have been arranged in the other towns.

South Bend merchants object to a proposed raise of rates for telephone service in that city, contending that such service as is now given is not worth the money charged for it. Before higher charges are imposed, the merchants declare, service should be much improved.

German Telephone Company, Bluffton, changed its name to Craigville Telephone Company.

A new 80-line switchboard has been installed at the Kirklin telephone office by Manager William M. Turner. It will be used for the present solely for toll business and calls to the free points. The board is now being operated from 7 a. m. to 1 p. m. and from 4:30 to 8:30 p. m.

At a meeting held recently in Galveston, a large crowd of Jackson township and Galveston telephone users met and organized the Galveston Telephone Company. The people of this section of the county have refused to pay the increased telephone rate and the above action has been the result. It is said that those who have paid the increased rate will discontinue the use of the Home telephone at the end of the quarter and join the co-operative movement.

Nappanee telephone cable lines are being placed underground.

Word was received in Auburn recently that the Central Union Telephone Company had petitioned for increased rates in practically all of the different classes of service of the Auburn exchange of the company. The Auburn petition is contained in a re-adjustment of rates asked in thirty-one cities and towns in Indiana. For Auburn the company asks that the individual business rate be increased from $3.50 per month to $4. For a two-party business telephone an increase from $3 to $3.50 is requested. For individual residence service, $2.25 is asked instead of $2 as at the present time. The charge for a two-party line, $1.75 per month, would remain the same. For a four-party residence telephone, the charge would also remain the same, $1.50 per month. For rural business, a charge of $2.50 is asked while the prevailing rate is $2. For rural res-

idence, $1.75 is asked instead of $1.50 as at present.

The Eastern Indiana Telephone Company recently petitioned the Public Service Commission for authority to put into effect a new schedule of rates to supplant federal established rates now in effect, and due to expire December 1. The petition asks that the schedule be made effective at Winchester, Lynn, Fountain City, Farmland, Red Key. The proposed rates are: Business telephone, individual, $2.75; two-party, $2.25; residence telephone, individual, $2; two-party, $1.50; rural telephone, business, $2.75; residence, $1.75. The Citizens Telephone Company of Dunkirk filed a petition to place in effect the following new rates: Business, individual, $2.25; two-party, $2; residence, individual, $1.75; two-party, $1.50; rural, business, $2.25; residence, $1.75. Both petitions are similar in form to petitions presented earlier in the day by the Central Union Telephone Company for new rates in thirty-one Indiana towns and cities.

IOWA

Articles of incorporation for the Laurel Hill Telephone Company, at Muscatine, a new rural corporation, have been filed in the county recorder's office. The company has as its principal place of business the school building of the Sweetland Independent School District No. 9, and is incorporated for a period of thirty years. Following are the officers and directors of the company: President, John F. Zybarth; vice-president and secretary, Fred H. Rost; treasurer, J. A. Zybarth. Directors, John F. Zybarth, Fred H. Rost, J. A. Zybarth, George Delaney, Joseph Lang, James Maher, Jr., Charles Marolf and William Weikert. The annual meeting of the company will be held the first Tuesday in February, 1920.

The directors of the Story County Independent Telephone Company met at the offices of the company in Nevada recently and laid the final arrangements for the purchase of a new switchboard for the plant at Maxwell. The old board there has been in use for some time and was in a bad state of repair, it having been rebuilt once. The capacity of the new board will be 400 phones, but it will not be used to the capacity at the present.

The Washington Telephone Company recently finished overhauling its rural lines, and constructing new lines to Titus and Wellman. A heavy force is employed on this work, and they will now turn their attention to construction of new branches of the Washington system, near Grace Hill.

The Mutual Telephone Company of Marengo has been combined with the Marengo Telephone Company.

KANSAS

The United Telephone Company is laying underground conduits at Lincoln, Belleville and Ellsworth preparatory to putting in underground lines and removing poles and wires from the street.

The government has purchased the Fort Leavenworth exchange from the Home Telephone Company, and has taken over the telephone service at the fort. It is understood that the government is to operate this with a free service to residences at Fort Leavenworth. There are four separate systems at the fort, the regular residence, the prison, the rock quarry and the army service schools, and they are all to be combined.

KENTUCKY

Unless the General Council takes action the present telephone tolls will remain in force in Louisville until December 1. At that time both companies automatically go back to the prewar schedule. The mayor stated recently that he would make no effort to have the rates reduced.

Neola Telephone Company, Neola, capital stock, $450. Incorporators: D. B. May, S. C. Alexander and H. H. Hollon.

Local managers of the Western Union Telegraph Company and the Cumberland Telephone Company at Paris, were notified recently that an order had been entered by the State Railroad Commission at Frankfort authorizing a continuance of the rates now in effect of the Western Union Telegraph Company and Cumberland Telephone Company. These rates were made while the companies were under government control. The commission in its order said that the increased rates are subject to attack by complaint of citizens at any time. The schedules were put into effect in April.

Improvements amounting to $10,000 will be installed within a short time in the equipment of the telephone company at Mandan.

MICHIGAN

The Michigan State Telephone Company is engaged in erecting a new copper telephone circuit to Winona. This circuit will be used to relieve the load carried on the existing circuit between Houghton and Rockland. That circuit is also employed in carrying the business between towns and the wire has been so crowded as to make relief necessary.

The Van Buren County Telephone Company has absorbed the Mutual Telephone Company of Bangor and the two exchanges hereafter will be operated as one.

Declaring that the Citizens Telephone Company, at Grand Rapids, cannot operate at the rate existing prior to December 1, 1918, Robert D. Graham, president of the company, told the city commission recently if the old rate is established there will be nothing for his company to do but to go into bankruptcy, and he has asked the federal court for a rate which will permit it to operate. Consequently plans for the proposed merger of the local properties of the Citizens and Michigan Telephone Companies are being held up, pending action by the Michigan public utilities commission.

One of the largest and most high-powered wireless telephone stations in the country is expected to be established at Selfridge field near Mt. Clemens, to facilitate training of airmen in this line of work. Planes at the local camp will be equipped with apparatus which will enable them to talk to each other or the stations on the ground.

An agreement for the merger of the Michigan State Telephone and Citizens' Telephone properties in Lansing, by which the Bell interests take over control of the entire system, is admitted by J. S. Gaylor, local manager of the Michigan State Company. Whether or not the contract is ever made effective, explains Manager Gaylor, depends on the telephone rate which is to be established by the public utilities commission. He says the company must have a rate which will justify the investment, if the merger is to be carried into effect.

Establishment of physical connection between Saginaw's two telephone systems is urged in resolutions adopted by the board of commerce.

MINNESOTA

The directors of the Redwood Falls Telephone Company, at a meeting held recently, decided to dispose of the business to the Tri-State Telephone & Telegraph Company. It is expected that the Tri-State will install a new switchboard in the Redwood Falls exchange, place the wires underground and make other improvements. A raise in rates is also anticipated.

Settlers in the Forsyth section have connected their homes with a private telephone line. They expect to extend the line to Littlefork at an early date.

Aitkin-Deerwood Telephone Company at Aitkin has had plans drawn for a one-story concrete store building with brick front, to house the exchange on the Cuyuna range to be located either in Crosby or Ironton. President De Laittre and Manager Moork have recently looked over the ground with an efficiency expert from Minneapolis to decide on the best place for a distribution center.

Permission to build a new rural telephone line in the vicinity of Eveleth is sought in a petition signed by nineteen persons and filed recently with the county auditor. It will be presented to the county board at its next meeting. The line will begin at Eveleth on the Mesaba trunk road and run from Eveleth to Iron Junction; on the Eveleth-Perry road from Spruce Junction to Central Lakes; on the Iron Junction road two and one-half miles west of Iron Junction; on the Woodland road one mile west of the intersection of the Eveleth-Perry road and the Woodland road, and then on the Hakala road one mile west of intersection of the Eveleth-Perry and Hakala roads.

Increasing the telephone toll rates has decreased the number of calls between Chisholm and Hibbing from an average daily number of 400 calls to less than fifty, according to manager Lester of the Mesaba Telephone Company, who appeared before the council recently opposing the placing of the wires underground. This, according to the official, has improved the service, because many of the calls were purely social. The business men, on the other hand, who were present at the meeting, retaliated by stating that the calls were reduced at the expense of the business men and that the reason the number of calls was lowered was because prospective customers cannot afford to pay a toll rate when they "shopped over the phone." Mayor Joseph Austin stated that the service since the toll rates became effective was not as good as it was before the system was introduced.

The Tri-State Telephone and Telegraph Company, at Albert Lea, has purchased the lot at the corner of St. Paul and Mill streets and will erect a building for its business. The property where the building is to be located has been known for years as the Radermaker corner. The building at the rear of the lot is for sale and must be moved by the middle of August. The new building will be ready for occupancy by January 1st if possible.

MISSOURI

An increase in phone rates of $1.00 per month, applicable to residence, business and physicians' phones which may include East St. Louis as a part of the St. Louis exchange, was filed with the Missouri Public Utilities Commission by the Kinloch Telephone Company recently.

For a good many years Warrensburg has had two telephone systems which necessitated every business man to keep two

telephones in his place of business if not in his home. Application is now before the public service commission in which the Home Telephone Company asks privilege to purchase the Bell system in that town for $30,000, payable in twenty annual installments. When permission is granted the systems will be consolidated and the service will be much more satisfactory.

Application for a further increase in telephone rates for Joplin and a request that the present rates be kept in force while a hearing is being held, was made recently to the Missouri Public Service Commission by the Home Telephone Company.

The Kinloch Telephone Company has asked the State Public Service Commission for permission to increase its rates for the various classes of service at the St. Louis exchanges, which include service at University City, Maplewood and East St. Louis. If the proposed new schedule is granted business telephones, including physicians' direct line, will cost the subscriber $1 more a month than the present rate. Two-party business lines will cost 75 cents more a month, and extra listing in the directory will be advanced $2 a year. Residence telephone rates will be increased 25 cents a month for two-party lines and 50 cents a month for four-party lines.

NEBRASKA

The Platte County Independent Telephone Company, at Columbus, is spending about $8,000 to put its lines in two of the paving districts underground. When completed there will be no wires overhead in the street and but one pole in the alley in each of the two blocks for distributing purposes. While the initial cost is large the maintenance will be less as there will be no opportunity for storm or fire damage.

The Surprise Telephone Company asks authorization to establish rates of $1.50 on farm lines and $1.25 on town residence two-party lines at both Surprise and Rising City.

The state railway commission recently made public an order for a hearing October 15 on the question of fixing service connection charges to be made by Nebraska Telephone Companies, pending conclusion of the hearing the commission order companies that had been charging the service connection rate to continuing doing so. This order, however, does not include those who have neglected collecting the rate, before.

The Lincoln Telephone and Telegraph Company, owners of the Auburn telephone exchange, has ordered a new modern switchboard to replace the one now in use here. The old switchboard was put in about six years ago and at the time was one of the finest in use in the state. It was thought at the time that it would answer the needs of the community for twenty years or more. The business has grown so that a larger and more modern board is required. The old switchboard is in sectional units and sections of it can be placed in exchanges in smaller communities where the company operates.

The Arlington Telephone Company has made application with the state railway commission for an increase of 25 cents on each telephone. The company claims that its maintenance account has fallen below what it should be and if it had been kept up it would have depleted the undivided profits account, and consequently the plant has been depleted both in labor and material. Its statement of last year's business shows gross receipts of $10,391.04, of which $2,256.04 is toll that must be returned to the Nebraska Telephone Company.

NORTH DAKOTA

Improvements amounting to $10,000 will be installed within a short time in the equipment of the telephone company at Mandan.

OHIO

New schedules increasing in several instances, rates even above those authorized by Postmaster General Burleson were filed with the state public utilities commission recently by the Central Union Telephone Company for 23 different cities in Ohio. No schedule was filed for Columbus.

Prosecutor William Dixon has asked the public utilities commission at Columbus for immediate restoration of the old telephone rates. If the commission grants his request, the rates will be the same as they were before the government took hold of the company.

OREGON

Telephone users in Eugene and Springfield are indignant over the fact that at the time the new telephone rates went into effect, a toll of 10 cents for telephoning between the two cities was made by the Pacific Telephone & Telegraph Company. Free telephone service between the two cities has been in vogue for many years. The franchise at Springfield calls for free tolls between that city and Eugene.

Articles of incorporation have been filed in Salem by the Williamette Telephone Company. The incorporators are H. Gilstrap, C. R. Burt and W. J. Furnish. The corporation is capitalized at $75,000 and the headquarters will be in Portland.

TEXAS

Work is well under way on the Stephenville telephone system and when completed will be the most complete on the Frisco lines west of Fort Worth. Fifty thousand dollars is being expended on the lines and a like figure will be used in constructing a plant and making other improvements.

The Southwestern Telegraph and Telephone Company has completed a survey of the city preparatory to the installation of a standard common battery telephone system at Cisco. The company through its representatives has assured the city authorities that this work will be completed by January 1.

The local telephone company at Fort Worth announced recently that it is engaged in installing additional facilities for the purpose of improving the local and long distance service that will require the expenditure of nearly half a million dollars. The improvements will include underground cable extensions, the installation of about a dozen more switchboards to take care of subscribers, many of whom are now on the waiting list, and the employment of many more girl operators to keep pace with the growth of the business and the city.

P. K. Higgins, president and general manager of the Port Arthur Telephone Company, announced recently that the plant had been leased to the Southwestern Telegraph and Telephone Company.

Actual work of placing the local telephone lines underground has begun, in Amarillo, according to statements made recently. In the agreement with the city commission the telephone company contracted to begin the work immediately after the lines were returned back to private control. The work is to be completed within a period of six months, according to the terms of the agreement, the project involving an expenditure of not less than $5,000. The agreement between the city commission and the telephone officials was made during the controversy over the raise in rates. While under government control authority for making the improvement could not be procured, and in the fight against the increased rate the telephone company was granted the right. The city continued its fight against the increased rate, and the agreement to place the lines underground was made.

The Southwestern Telegraph and Telephone Company, at Beaumont, recently opened up for business in its new four-story building at Liberty and Main streets. The building has modern equipment and the new board has a capacity of 4,000 lines, which means that about 6,000 telephones can be handled without further extension. C. W. Emmeris, the local manager for the company, puts the building cost at about $75,000.

WEST VIRGINIA

The Chesapeake & Potomac Telephone Company recently notified its subscribers in the Clarksburg district that it had applied to the State Public Service Commission for an increase in rates amounting to an average of 20 per cent all over the state and about 22 per cent in the Clarksburg district over existing rates, which were raised several months ago to meet war-time conditions. The proposed increase here for business telephones is from $4.50 to $6.25 a month and for residence telephones from $2.75 to $3.75.

Under the proposed new telephone rates farmers' telephones at Wheeling will cost about $33 per year. When the various lines in Ohio County were first built, a rate of $15 a year was made.

WISCONSIN

The La Crosse Telephone Company has asked the railroad commission to increase its preferred capital stock to the extent of $10,000, to cover the cost of building additions and other improvements. Officially notified by the railroad commission of the application of the company, City Attorney O. J. Swennes, in a letter to the state board, announced that he would not appear at the hearing, but reserved the right, in behalf of the city, to object to any increase of capital for rate making purposes.

The Badger State Telegraph & Telephone Company, of Wellsville, Wis., has applied to the railroad commission to increase its rates as follows: Two-party business telephones, from $24 to $27 per annum; magneto (Granton) two-party, from $24 to $27; residence, from $18 to $21; two-party residence, from $15 to $18; four-party residence, from $12 to $15; magneto (Granton) from $15 to $18; listing a non-subscriber from $4 to $6; rural telephones raised to $24 per year when paid in advance, or $26 when not so paid. It is also asked that the switching rate at Granton be raised from $4 to $6 per annum per telephone. The company recites that the revenues under the present rates are inadequate to furnish a fair return on the investment, giving detailed figures to substantiate this claim. It also states that the new compensation law which went into effect August 1, making the minimum wage for women 22 cents per hour, will wipe out all the profits for the investors in the business.

Citing expense of switchboard operators to be nearly doubled because of newly enacted laws governing hours of service for women, that the petitioner "will have to" increase the wages of linemen from 35 to 50 cents an hour and divers increases of rent, fuel, etc., the Cottage Grove Telephone Company, at Madison, has petitioned the Railroad Commission for permission to double its rates.

CLASSIFIED INDEX

Ammeters.
Leeds & Northrup Co.
Thompson-Levering Co.

Anchors.
Oshkosh Mfg. Co.

Automatic Telephones.
Automatic Electric Co.

Batteries, Dry.
Stromberg-Carlson Tel. Mfg. Co.
Western Electric Co.

Battery Savers.
Kellogg Swbd. & Supply Co.
American Technical Society.
Stromberg-Carlson Tel. Mfg. Co.

Boards, Power.
Stromberg-Carlson Tel. Mfg. Co.

Books.
Telephone Engineer.

Booths.
Stromberg-Carlson Tel. Mfg. Co.

Cables.
American Steel & Wire Co.
Electric Cable Co.
Indiana Rbr. & Ins. Wire Co.
National Conduit & Cable Co.
Roebling's Sons Co., John A.
Simplex Wire & Cable Co.
Standard Underground Cable Co.
Stromberg-Carlson Tel. Mfg. Co.
Western Electric Co.

Cable Clamps.
Standard Underground Cable Co.

Cable Hangers.
(See Hangers, Cable.)

Cable Terminals.
(See Terminals, Cable.)

Cleats, Insulated.
Electrose Mfg. Co.

Climbers.
Oshkosh Mfg. Co.

Coils.
Automatic Electric Co.
Leeds & Northrup Co.
Thompson-Levering Co.
Premier Electric Co.

Condensers.
Automatic Electric Co.
Stromberg-Carlson Tel. Mfg. Co.

Conduit.
Shawmut Clay Mfg. Co.

Construction Materials.
Automatic Electric Co.
Oshkosh Mfg. Co.
Kellogg Swbd. & Supply Co.
Stromberg-Carlson Tel. Mfg. Co.
Western Electric Co.

Cords.
Automatic Electric Co.
Premier Electric Co.
Kellogg Swbd. & Supply Co.
Stromberg-Carlson Tel. Mfg. Co.

Distributing Fixtures.
Cook Company, Frank B.

Electrical Instruments.
Leeds & Northrup Co.
Thompson-Levering Co.

Engineers.
Clement, Edward E.
Fowle, Frank F.

Flat Wire.
American Steel & Wire Co.
Roebling's Sons Co., John A.

Flux, Soldering.
Benson, Alex R.
Blake Signal & Mfg. Co.

Fuses.
Cook Company, Frank B.

Galvanometers.
Leeds & Northrup Co.
Thompson-Levering Co.

Generators.
American Electric Tel. Co.
Kellogg Swbd. & Supply Co.
Leich Electric Co.
Stromberg-Carlson Tel. Mfg. Co.
Western Electric Co.

Guy Anchors.
Oshkosh Mfg. Co.

Guy Clamps.
Cook Company, Frank B.

Hangers, Cable.
Cook Company, Frank B.
Standard Underground Cable Co.

Harmonic Ringers.
Kellogg Swbd. & Supply Co.
Stromberg-Carlson Tel. Mfg. Co.

Heat Coils.
Cook Company, Frank B.

Hook Switches.
Automatic Electric Co.
Kellogg Swbd. & Supply Co.
Leich Electric Co.
Premier Electric Co.
Stromberg-Carlson Tel. Mfg. Co.

Insulated Staples.
Blake Signal & Mfg. Co.

Insulated Tape.
New York Insulated Wire Co.

Insulation Composition.
Electrose Manufacturing Co.

Intercommunicating Systems.
Automatic Electric Co.
Kellogg Swbd. & Supply Co.
Stromberg Carlson Tel. Mfg. Co.
Western Electric Co.

Joints, Wire.
Cook Company, Frank B.

Keys.
American Electric Tel. Co.
Kellogg Swbd. & Supply Co.
Stromberg-Carlson Tel. Mfg. Co.

Lightning Arrester.
Cook Company, Frank B.

Linemen's Climbers.
Oshkosh Mfg. Co.

Magnet Wire.
American Steel & Wire Co.
Automatic Electric Co.
Kellogg Swbd. & Supply Co.
Roebling's Sons Co., John A.
Standard Underground Cable Co.
Stromberg-Carlson Tel. Mfg. Co.
Western Electric Co.

Manhole Covers.
American Brake Shoe & Fdry. Co.

Mouthpieces.
Electrose Mfg. Co.

Nails, Copper.
American Steel & Wire Co.

Patent Experts.
Clement, Edward E.

Patent Solicitors.
Clement, Edward E.

Pay Stations.
Automatic Electric Co.

Pay-Out Reels.
Oshkosh Mfg. Co.

Platinum.
Baker & Co.

Poles, Cedar.
National Pole Company.

Powder.
Du Pont Powder Co.

Rebuilt Telephones.
Premier Electric Co.

Receivers.
American Electric Tel. Co.
Automatic Electric Co.
Kellogg Swbd. & Supply Co.
Leich Electric Co.
Premier Electric Co.
Stromberg-Carlson Tel. Mfg. Co.
Western Electric Co.

Receiver Cords.
Automatic Electric Co.
Kellogg Swbd. & Supply Co.
Leich Electric Co.
Premier Electric Co.
Stromberg-Carlson Tel. Mfg. Co.

Receiver Shells.
Electrose Mfg. Co.

Ringer Sets.
Automatic Electric Co.
Kellogg Swbd. & Supply Co.
Leich Electric Co.
Premier Electric Co.
Stromberg-Carlson Tel. Mfg. Co.

Ringing Machines.
Automatic Electric Co.
Kellogg Swbd. & Supply Co.
Stromberg-Carlson Tel. Mfg. Co.

Selectors.
Automatic Electric Co.
Kellogg Swbd. & Supply Co.

Staples, Insulated.
Blake Signal & Mfg. Co.

Soldering Paste.
Benson Co., Alex R.
Blake Signal & Mfg. Co.

Soldering Salts.
Benson Co., Alex R.

Supplies.
Automatic Electric Co.
Kellogg Swbd. & Supply Co.
Premier Electric Co.
Stromberg-Carlson Tel. Mfg. Co.

Switchboard Cable.
Automatic Electric Co.
Kellogg Swbd. & Supply Co.
Leich Electric Co.
Standard Underground Cable Co.
Stromberg-Carlson Tel. Mfg. Co.

Switchboard Coils.
Automatic Electric Co.
Kellogg Swbd. & Supply Co.
Leich Electric Co.
Premier Electric Co.
Stromberg-Carlson Tel. Mfg. Co.

Subway Castings.
American Brake Shoe & Fdry. Co.

Switchboard Cords.
Automatic Electric Co.
Kellogg Swbd. & Supply Co.
Leich Electric Co.
Premier Electric Co.
Stromberg-Carlson Tel. Mfg. Co.
Western Electric Co.

Switchboards, Telephone.
American Electric Co.
Automatic Electric Co.
Kellogg Swbd. & Supply Co.
Leich Electric Co.
Premier Electric Co.
Stromberg-Carlson Tel. Mfg. Co.
Western Electric Co.

Tacks.
American Steel & Wire Co.

Take-Up Reels.
Oshkosh Mfg. Co.

Tape, Insulated.
New York Insulated Wire Co.

Telephones.
Automatic Electric Co.
American Electric Co.
Kellogg Swbd. & Supply Co.
Leich Electric Co.
Premier Electric Co.
Stromberg-Carlson Tel. Mfg. Co.
Western Electric Co.

Terminal Blocks.
Cook Company, Frank B.

Terminals, Cable.
Cook Company, Frank B.
Standard Underground Cable Co.

Test Connectors.
Cook Company, Frank B.

Testing Sets.
Leeds & Northrup Co.
Thompson-Levering Co.

Tools.
Oshkosh Mfg. Co.

Transmitters.
American Electric Tel. Co.
Automatic Electric Co.
Kellogg Swbd. & Supply Co.
Leich Electric Co.
Stromberg-Carlson Tel. Mfg. Co.
Western Electric Co.

Voltmeters.
Leeds & Northrup Co.
Thompson-Levering Co.

Wire, Copper.
American Steel & Wire Co.
Electric Cable Co.
National Conduit & Cable Co.
Roebling's Sons Co., John A.
Standard Underground Cable Co.

Wire, Copper Clad.
Roebling's Sons Co., John A.
Standard Underground Cable Co.

Wire, Galvanized Iron.
American Steel & Wire Co.
Indiana Steel & Wire Co.
Roebling's Sons Co., John A.

Wire Rods.
American Steel & Wire Co.
Standard Underground Cable Co.

Wire Rope Fittings.
American Steel & Wire Co.
Roebling's Sons Co., John A.

Wire, Rubber Covered.
American Steel & Wire Co.
New York Insulated Wire Co.
Roebling's Sons Co., John A.
Simplex Wire & Cable Co.
Standard Underground Cable Co.

Wire, Strand.
American Steel & Wire Co.
Indiana Steel & Wire Co.
Roebling's Sons Co., John A.
Standard Underground Cable Co.

Wire, Weatherproof.
American Steel & Wire Co.
Electric Cable Co.
Indiana Rbr. & Ins. Wire Co.
National Conduit & Cable Co.
New York Insulated Wire Co.
Roebling's Sons Co., John A.
Simplex Wire & Cable Co.
Standard Underground Cable Co.

Wires and Cables, Electric
Kellogg Swbd. & Supply Co.
Roebling's Sons Co., John A.
Standard Underground Cable Co.
Stromberg-Carlson Tel. Mfg. Co.
Western Electric Co.